THE JOURNAL OF MICROSCOPY AND NATURAL SCIENCE:

THE JOURNAL OF

THE POSTAL MICROSCOPICAL SOCIETY.

EDITED BY

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Honorary Secretary of the Postal Microscopical Society.

ASSISTED BY

SEVERAL MEMBERS OF THE COMMITTEE.

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Preface.

THE JOURNAL OF MICROSCOPY AND NATURAL SCIENCE has now reached its Fifth Volume, and we may congratulate ourselves upon the steady increase in the number of our subscribers and readers as a proof of its good standing and prosperity.

The testimony we so frequently receive as to the aid of the Notes selected from the Note Books of the Postal Microscopical Society, in opening up new avenues for enquiry in Microscopical study, more especially with respect to their value for constant reference, is of itself sufficient to increase our expectation of a more extended and substantial success.

We have taken care to select from the contributions sent to us, only such articles as we feel certain would be of the greatest interest and usefulness to all engaged in Natural Science; and we earnestly ask the co-operation of our friends, and especially the members of the Postal Microscopical Society, to help us in extending the circulation of our Journal, so that the influence of the work may be felt in yet wider circles.

With respect to Reviews and Notices of New Works, it is our desire to notice every book sent to us whatever be its position in

the ranks of literature, our aim being simply to give such a description of it as will at once satisfy our readers that it is, or is not, such a one as they may require.

It is with much satisfaction that we look back to the work of the past year; it was a period of great labour, and of much anxiety, which however has borne goodly fruit, and we beg very cordially to thank our numerous contributors for their valuable papers. Our thanks are also due to Dr. Muter, Editor of the *Analyst*, for permission to transfer to our pages the interesting paper on Microscopic Crystallisation, and for the loan of the blocks from which the plates illustrating it were printed.

Nor must we omit to thank very heartily our many subscribers for their generous and liberal support. We are pleased to be able to inform them that we have a number of very excellent papers in store for our *Sixth* Volume. We also beg to state that a General Index is in preparation, and will be issued with the October part of Vol. VI.

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JANUARY, 1886.

Presidential Address.

OCTOBER 7TH, 1885.

President: Rev. E. T. STUBBS, M.A.

IN taking my seat as your President for this year, I have to thank you in the first instance for the honour you have done me, in electing me to this high position, for which I feel myself so unworthy.

You will allow me in taking the chair, to say a few words about our Society itself. I feel that those words are to reach forth to a further and a wider circle than that now before me, and that they will become known, not only to the members of the Postal Microscopical Society who are in this room, and to the kind visitors and guests who have honoured us with their presence, but to many others besides.

This address, then, is for a more extended audience than this room contains, for I know that by means of our Journal, as well as by other ways, what I say now will be read by the members of

this Society, who are scattered throughout the United Kingdom. You will pardon me, then, if any of my remarks may appear not altogether suited to the present assemblage.

I wish to speak about our Society itself,—its special character; the advantages which seem peculiarly to belong to it, and how to improve these; its disadvantages, drawbacks, and hindrances, which are not altogether inseparable from its constitution; and how far they may be corrected; in a word, I want to consider how best to carry on the Postal Microscopical Society; how to make the most of it; how to advance and improve it; how to make it a useful and a pleasant Society to belong to.

But before entering upon the special subject which I have chosen for this address, let me express the sorrow of myself and of the Postal Microscopical Society, at the removal by death from amongst us of Dr. Brown, of Ealing, a late President of this Society, and one of its earliest and most distinguished members; a man ardent in the study of microscopy, very sincere and earnest in his work for the Society, whose notes in our note-books were frequent, and always instructive, and whose slides were most interesting; his loss will be greatly felt, and his place not easily supplied.

Now, since the object and aim of the Postal Microscopical Society is simply to promote Scientific knowledge, and research in the world of minute objects, every honest worker, then, ought to find a welcome amongst us. It surely should not check that welcome, or lessen our cordiality, that he has not mastered the mere elements of his work; we should be glad to reach forth to him a helping hand; was there not a time in the lives of each of us when we too were beginners, when we had not learned even the alphabet of our Science? We must, therefore, on our part, act towards him, just as we expect the beginner on his part to be modest and diffident, and not mistake his crude ideas for undoubted truths; but to go on adding to his stores of knowledge, making sure progress, and treading on firm ground, by using as he may the observations and experience of his elders in the science. But we must not forget that our main desire is to enlist in our ranks those to whom we can look for further help and profit in our microscopical studies. And, then, let us all endeavour

to stimulate each other to closer research into the microscopic world of nature, so many of whose departments have been hardly yet investigated. For all our members ought to be more or less workers, not mere drones, doing nothing for the Society's general good, and taking no interest in microscopical pursuits.

Very various and diversified is the classification of our members. There is the soldier, the sailor, the lawyer, the clergyman, the merchant, the tradesman, the physician, the chemist, the schoolmaster; the man of toil and the man of ease; the gentle lady, the invalid, and the strong; professional and non-professional men: all these belong to us. England, Ireland, Scotland, and even Portugal, contribute their quota of members; there is vast diversity of training, of surroundings, of taste, and of leisure amongst us; and the common bond which unites us all, is a love for microscopical pursuits.

Now, it is no small advantage and benefit to have in our Society men of such varied training and of such diverse habits, not to speak of the further differences of mind, and systems of thought which so strangely mark different nations, and even different portions of the United Kingdom. For the same thing will strike different people in very different ways; so we must expect a great variety in the expression of opinion amongst ourselves; and we ought to welcome such differences, for in this way it is that a statement or a matter can more thoroughly be investigated, when it has to endure the fire of criticism. But I need not say that the criticism should be kindly given, and as kindly received. A man is not worth his salt if he cannot bear to see his pet hobby upset and declared to be absurd, or his favourite opinion proved wanting and impossible; shallowness of information and scantiness of knowledge generally betray themselves by irritation and impatience of criticism, just as, on the other hand, poor and trifling criticism shows a meagrely furnished mind.

Now, one great disadvantage under which the Postal Microscopical Society labours, arises from the fact that we have never and can never meet altogether; our homes are so wide apart, and we are practically an aggregate, not so much of individuals isolated and at a distance from each other—though this is the case in some instances, but an aggregate of many smaller societies which

gather each around its own centre, but which may know little or nothing of other centres. It is a great advantage to be able to look one another in the face, and in living words to discuss and criticise each other's conclusions; but the very constitution of the Postal Microscopical Society necessarily precludes this personal intercourse, and we can know each other merely through the inspection of our slides, and by the cold criticism of our note-books. There is, however, a counter-balancing advantage; for as our remarks have to be all written, they are more carefully thought over, and more accurately expressed; for we all recollect that, *Litera scripta manet;* and besides this, we are often given very valuable extracts from works on microscopical subjects, to which we may not have had access, or at least towards which our attention had not been before directed. I am aware that some of our members have objected to the insertion in our note-books of extracts from well-known authors, but it seems to me that, on the whole, even such extracts are an advantage rather than otherwise.

But with respect to the notes we may make on the slides which come to us, it surely is a good rule to lay down for our own guidance, " If you have nothing to say, don't say it," as on the other hand, " If you have anything to say, don't be afraid of saying it." Don't shrink from making a remark because you think it possibly has been made before; some may find your remarks quite new to them, and to those who have heard it before, it is often an advantage to have old information furbished up and freshened in the memory. There are one or two points respecting our note-books which it would be well to remember. There ought to be some uniform system of arrangement; begin each note-book, not on the first page, but leave at least four pages blank, and begin your notes on the fifth page; the secretary will require those first blank pages to affix the list of circuit, the catalogue of slides, etc.; write on one side only of the page (the right side is preferable); and number the pages so written *consecutively*, for the purpose of reference; in this way the notes will be clearer, and much confusion will be prevented. The blank off-sheets will serve for any small sketches which you may find necessary to insert; I here allude to diagrammatic sketches. But regular drawings or photographs ought to be made upon special paper, which the

Secretary will send to any member who desires it, and these should be placed at the *end* of the note-book, beginning at the *last* page, and thus must be numbered the *reverse* way, that is, backwards. It is the greatest possible help to our notes, to accompany them with sketches or more careful drawings; and every member should, if it is in his power, give some with his slides; but it is all-important that they should be done in something permanent, not surely in pencil, but in some way in which they will bear rubbing, and will retain exactness of outline.

There is here one great disadvantage under which we all labour. We dread to risk our best slides and most carefully prepared specimens to the unavoidable rough treatment of the postal bags, as they are flung down upon the platform of a roadside station from a passing train; and it is with no small sigh of relief that we greet our slides when they return unhurt to our hands, after a two years journeying about from member to member; just as on the other hand there is a pang of sorrow when we find the cover-glass displaced or broken, and our choice specimens irretrievably damaged. I can only advise all our members to cement their slides most carefully, and not to study appearance and finish so much as security; and I need not say that our indefatigable Secretary ought at once to be made cognizant of any accident which may occur to either boxes or note-books, or damage to the slides. Still, in spite of this disadvantage, and in the face of this risk, do not let us withhold from circulation our really good and useful slides; for as most of us have read,—"Great objects exact a venture, and a sacrifice is the condition of honour."

And, now, having alluded to the Secretary, I may be permitted to say a word about our relations with him. The Secretary of every Society, scientific societies especially, is really the most important officer; the President is little else than an ornamental addition,—he takes the chair at meetings, and directs pleasant gatherings like the present one; but it is the Secretary who manages the entire working, and in a Society so constituted as this is, upon such management the very existence of the Postal Microscopical Society depends; the Secretary is the head to arrange and plan the different groups of members; he is also the heart to keep

up the circulation of boxes to the furthest extremities and most distant parts of the Society. When I have seen the pile of boxes and the multiplicity of material heaped up in his room, I have often marvelled that such regular issue of boxes can be kept up, and any orderly management carried out. Now, we should do all in our power to assist the Secretary in his work, by not detaining unduly the boxes as they come into our hands, and by at once communicating to him any irregularity that may be perceived, and every accident that may occur.

From the peculiar constitution of the Postal Microscopical Society, one of the very essentials of its success—indeed, I may say, of its existence—depends upon the regularity and punctuality of each member in the circulation of the boxes. The Secretary does his best to maintain that circulation, but each member must heartily second his efforts; let the name of Box-stopper be felt to be a stigma, for recollect that every box-stopper so far impairs the vitality of the Society.

I find that very frequent complaints are made both of the non-receipt of boxes, and also of their overcrowding; one evil follows the other; congestion of boxes follows their stoppage. Not very long ago eight boxes were received from one member by the Secretary in one parcel, and four boxes from another; and both members at the same time sent in their resignation, giving as a reason, that they could not pay proper attention to the requirements of the Society. Now, of course, we wish to retain all our working-members, but those who either stop or congest boxes, and who find it impossible to observe regularity in the circulation of them at proper dates, had far better resign at once, with honour and credit, than first to allow boxes to accumulate for four or five months from their own unpunctuality, and then resign! Surely, there is no more effectual way than this of throwing the entire machinery of the Society out of gear, and casting discredit on its management, besides diminishing its usefulness.

And it is often very difficult to trace the box-stopper; frequently ten or twelve letters must be written in the endeavour to find him out,—thus giving trouble, expense, and annoyance, to many who are quite innocent. It is in fact the inflammation which attends congestion. A little foresight will generally prevent any

detention of boxes; as when a member is going off for a holiday, or likely to be absent from home for some time, he should, if he can, apprise the Secretary of this a few days previously, and also the previous member on his list. The Secretary not unfrequently receives a note "Please send me no more boxes for two months, as I start for the Continent to-morrow!" A day's post is lost in writing to the preceding member, on the part of the Secretary, while that member may probably have already despatched one or more boxes to the intending tourist, who thus becomes, I am sure, very unwillingly, but for want of a little foresight, a box-stopper!

I would like to add a word about the Journal which is associated with our Society. I think I am right in saying that the Postal Microscopical Journal has well-nigh fairly established itself before the public. There are certain difficulties peculiar to it, and certain disadvantages which it has had to encounter, some of which arise from the fact that the ground has been more or less covered by other periodicals of a similar kind, and which have had the advantage of a prior start, and this was urged as an objection to its publication by one very valued member. It was in order to meet that difficulty in some degree that the scope of the Journal was enlarged, and its title consequently added to, and it now bears the name of "The Journal of Microscopy and Natural Science: the Journal of the Postal Microscopical Society."

I think the notes of the Postal Microscopical Society's Note-books ought to form a very principal and prominent item in each number of the Journal, so as to keep up and maintain its claim to the latter portion of its title. But it is a much greater labour than many can be aware of, to select from a mass of notes of a most miscellaneous character, that which is of most value. That some of our members do insert in the note-books matter which is extremely useful and important, we well know; and that there are sketches and illustrations accompanying many of those notes incomparable for beauty of execution, and accuracy of detail, and fineness of work, we are also well aware; all these are worth preserving. I know that, in spite of the great labour entailed thereby, the editor of the Journal is sincerely anxious to do this.

There is another disadvantage attaching to the Journal which

I must allude to. Though it bears the Society's name as a portion of its title, it is really a private adventure made by our Secretary, who is wholly responsible for it. Such is not the case in other scientific societies, their Journals are their own property, and they bear the burden of the maintenance of them. In fact, this Journal was set on foot simply because the Secretary had in his possession an immense mass of valuable matter, scattered up and down in miscellaneous notes of the note-books, which books had finished their circuits among the members, and he was unwilling that these should be consigned to oblivion and perish ; it seemed to him that these notes and their accompanying drawings were well worth preserving; it was then for this reason that he has, alone and unaided, set on foot the Journal. Now it rests with ourselves especially to make that Journal a success, and this may be effected by each member taking one or more *additional* copies for their friends; recollect that as now arranged each member is entitled to one gratuitous copy; and we may forward its progress as well as raise the character of the Society itself, by each member taking very special pains in the notes and drawings inserted in the note-books of the Society.

Let me, before I close, point out some well-nigh untrodden domains of microscopical study, and whither it would be well to direct our researches. The *Sections of Roots* is a department almost unstudied, also *Sections of Ovaries and Seeds ;* then, there is that immense world of *Marine Life*, so various in both its animal and vegetable structure; the variety and strange forms of *Marine parasites*, which the different Aquaria in England and in other countries are gradually making better known. There is much to be discovered in these branches of study, and our patient investigation is sure to be rewarded. It was once proposed to introduce living specimens into our circulation, but that was of course found to be quite impracticable; however, I need not point out how important it is that each of us should, so far as opportunity serves, study the *living* specimens. I recollect how much more I learned in seeing in a living specimen of one of the *Siphonostomata*, and how much I learnt by studying the action of the mouth and also the intestinal movements of the creature, of which I had never read a description. And this year I had a good opportunity of observing the circulation in the *Argulus Foliaceus*.

And now, in conclusion, let me add a word or two upon the advantages to be derived from the general study of nature; premising that the following remarks are not original, but noted down by me from an author whose name I have forgotten, but which may perhaps occur to some of you.

When we study with care and attention the order of Nature, we shall find in what direction such obstacles lie in our path which cannot be surmounted. It is well to know where the path is really barred and where *impossibilities* stand in the way of research; we learn then not to *waste time or effort.* Marvellous things have been done, for example, in the investigation of diatom valve-markings; but as we all know, when we use the higher powers, diffraction and interference of rays come in to obstruct and to hinder, so much so, that some men have thought that research into these cannot be possibly pushed much further. And search how we may, we see fresh forms shadowing themselves forth, which we vainly try to define, and of the object and purpose of which we may not be able to form even an idea. But further, we are enabled by experience to use those means in our research, which are *adequate* to the purpose in hand, or which at least are not *opposed or inconsistent.* And further, again, we learn to make use of the *easiest* and *most economical*, and most *efficient* means to accomplish our end. And, lastly, we are induced to *go forth into paths hitherto unknown and untravelled*, and to make research in directions *unattempted* and *untried* before. In a word, the close and careful study of the order of Nature, will point to four things:—1.—Where *impossibilities* are to be met with; 2.—What are the *best means* to make use of; 3.—What is the *best method* to adopt; 4.—To encourage *research.*

We are all engaged in such investigations; we are all learners from the great book of Nature; the best of us are hardly able even to spell out its great words of truths; we all feel that we have grasped but the slightest portion of the surface of the vast infinitude of the microscopical world. We can but as children dip only into the shallows and tiny pools that lie before us, while there stretches away into the far distance the mighty ocean of further marvel, wisdom, and design, still remaining unfathomed and unknown.

The Mouth-Organs and other Characteristics of the British Geodephaga (Ground Predaceous Beetles).

By Robert Gillo.

Plates I., II., III.

PERHAPS a few words of general introduction may not be out of place to get as clear an idea as possible as to what the characteristics of the *Coleoptera* really are. Of all the different characters by which beetles may be known, we can only detect two which are constant—namely, Mandibulate mouth-organs, and Complete metamorphosis. By the latter term we mean that they pass through four stages: the egg, larva, quiescent pupa, and imago or perfect insect. It ought to be stated in passing that Kirby and Spence in their great work, and other old authors, describe the metamorphosis of beetles as incomplete. This was evidently the accepted opinion of the naturalists of that age, but now the metamorphosis of beetles is always considered by naturalists to be complete.

Since writing the above, "Westwood's Introduction to the Modern Classification of Insects" has come into my possession, and in it I find this note:—"It has been usual to apply the character of the pupa to designate the peculiar nature of the metamorphosis in general. This is, however, very incorrect; since the *Coleoptera* are thereby defined to have an incomplete metamorphosis, whereas their metamorphoses are complete, in the ordinary acceptation of the word, the pupa being, on the contrary, incomplete. Moreover, Linnæus applied this and other similar terms to the pupa and not to the metamorphosis; the confusion originating in their misappropriation by Fabricius." The pupæ of beetles generally have all the parts of the future imago plainly visible, being encased in thin sheaths. In some instances, however, the limbs are closely soldered to the body, and apparently enclosed in

a single sheath, thus approaching very near to the pupæ of the Lepidoptera.

Of the other characteristics, the most striking, and the one to which there are fewest exceptions, is that which led Aristotle to name them Coleoptera, or sheathed wings. This designation refers to the hard wing-cases called Elytra, which normally meet in a straight line down the back and protect the membranous or flight-wings from injury when they are present. Usually, these wing-cases are quite hard and brittle; but by way of exceptions we have the whole of the family of the *Malacoderma* and many others, which have the elytra soft and leathery. The Soldier Beetles (*Telephorus*) are good examples. Again, we have the females of *Drilus flavescens* and *Lampyris noctiluca* (the glow-worm), which are entirely wingless and possess no elytra. The former, and more particularly the female, is very rare; both it and the glow-worm are carnivorous, feeding on slugs and snails. There is also another species of beetle, *Phosphænus hemipterus*, of which the female is entirely apterous; the male has very short elytra and no posterior wings. It is a very rare insect.

In the genera *Metoecus* and *Sitaris* (Figs. 1 and 2) the elytra touch only at the base, and do not cover the posterior wings, giving the insects very much the superficial appearance of the Hemiptera, or bugs. The genus of the first was originally called *Rhipiphorus*, from the form of the antennæ of the male, which has processes on both sides of each joint, arranged in a fan-like manner; this name is still retained for the sub-family. The specific name, *Paradoxus*, was given to it because nothing was known of its life-history; but from careful observation, it has been ascertained that it inhabits the nests of wasps, its larvæ being parasitic on the larvæ of wasps. The second example, *Sitaris muralis*, is also parasitic on certain solitary bees which inhabit holes in walls. It appears that the *Sitaris* lays its eggs at the entrance to these holes, and the young larvæ, when hatched, crawl into the nest and attack the larvæ of the bees. It is a very rare beetle in Britain, but is common on the Continent.

In the well-known Oil Beetle (*Meloë proscarabæus*) we have another example of elytra which not only diverge, but actually lap over at their bases; they are also very soft, and the posterior

wings are entirely absent. This beetle lays its eggs in the earth at the root of some suitable plant. As soon as the larvæ are hatched, they crawl up the stem of the plant, and get into the flower, where they rest until a bee alights upon it, when they attach themselves to the bee, and in this way get carried to the bee's nest, when they immediately leave the bee and attack the larvæ. It appears worthy of notice that these three beetles, which, from a study of their structure, were placed close together in classification, should, when their life-history became known, prove to be so similar in their food and habits. It would seem to show that there is not only a similarity of form, but a real relation or kinship. Numerous other instances may be cited to the same effect.

In a great many genera of beetles, the posterior wings used for flying are very well developed, and in the Longhorns and those of similar form they merely rest one on the other without folding; the great length both of the body and of the elytra rendering folding unnecessary, but in the case of the majority of the beetles (such as the Cockchafer, Dor Beetles, etc.) this is not possible, and therefore they have to be folded. In the wing of the Dor Beetle, it will be observed that the great costal nervure at the point of flexure has a kind of knee-joint, and the other nervures are so arranged as to naturally fall into folds. It is a much simpler arrangement than that of the Earwig, which is folded both transversely and in a fan-like manner, and differs considerably from that of the crickets, which have wings that close up precisely like a lady's fan.

In the case of the *Brachelytra*, which have long, membranous wings, and very short elytra under which they have to be stowed away, the method of folding is the same, except that there are two additional folds; the knee-joint in the costal nervure is folded only one-third of the entire length of the wing from its base, the remaining two-thirds being folded once over and once under.

The eyes are compound, generally two in number, but the Water Beetle (*Gyrinus*), or Whirligig, has four distinct compound eyes, two of which are for looking upwards or above the water, and the other two for looking downwards into the water as it spins about on the surface, looking like a drop of quicksilver. Some of

the Longhorns, also, have four eyes. Many of the small *Brachelytra* have stemmata, or simple eyes, as well as compound ones. *Homalium rivulare* may be named as an example, and there are a great many others.

Again. Some beetles are entirely eyeless, as the *Claviger foveolatus* (Fig. 3), a small yellow beetle, only one-twelfth of an inch in length, found in the nests of the yellow ant in chalky districts. A popular writer tells us that this beetle also has no mouth; but this is incorrect, as it has well-formed mouth-organs. The ants appear to be very fond of it, and are continually licking it over on account, I believe, of a fluid which it secretes, and for which the ants have a great liking. Another beetle that is quite blind, is the *Anommatus duodecim-striatus* (Fig. 4), a beetle about one-sixteenth of an inch in length, found in stores of flour and meal. Both of these insects are rather rare.

The antennæ of beetles are of very various forms, and are in a great many cases the basis of classification, as the *Lamellicornia*, *Clavicornia*, *Longicornia*, and so on. I must not say anything about them in the present paper, but will only remark that normally the antennæ have eleven joints, although to this rule there are exceptions, some having more and others less.

The beetles now known to inhabit Britain are about 3,250 species; these, in the most modern classifications, are divided into twelve sections, the first of which is the ADEPHAGA, or predaceous beetles—the carnivora, so to speak, of the Coleoptera. This section is divided into two well-marked and distinct sub-sections, namely—the GEODEPHAGA, those which live on the land, and the HYDRADEPHAGA, or Water Beetles. Although the mouth, which is the important point in this section, is similar both in the GEODEPHAGA and in the HYDRADEPHAGA, the general form of the beetles is very dissimilar, as will be seen by comparing Figs. 5 and 6, so that there need be no fear of confusion. Those of the one sub-section have a more or less triangular head, square or heart-shaped thorax, and parallel-sided elytra, not deeply inserted one into the other, but each part free and distinct; the legs, also, are long and suited for running on the land. Those of the other sub-section are so formed that they are of a nearly oval figure, without any projections; in a word, boat-shaped, with legs spe-

cially constructed, something like oars, for propelling the insect through the water.

The mouth-organs of beetles, although all mandibulate and constructed on the same plan, exhibit a great variety of forms in their respective organs, according to the nature of the food on which the insects subsist. Thus we find the carnivorous beetles have mandibles very much like the canine teeth of the tiger; whereas those that feed on vegetables have their mandibles modified so as to act partly for cutting, but more particularly for crushing, their food, like the molar teeth of the mammalia. At the outset we are struck by the fact that all insects have mouth-organs which work laterally, whereas all the vertebrata have the motion of their parts vertically.

The mouth-organs of a beetle consist essentially of six parts, namely: the *labrum*, or upper lip; the *labium*, or lower lip; and between these there are two pairs of jaws, known as the *mandibles* and the *maxillæ*. The head which carries these organs is a box, or perhaps more correctly a ring of chitine, articulated at its base into the thorax, and open at the apex for the reception of the various parts of the mouth. The front of this ring, or head, on the upper side is called the *Clypeus*, on to which the labrum is hinged like a flap; it is usually square or oblong, but sometimes rounded, slightly emarginate, or deeply cleft. On the under side of the head there is, first, a plate, called the *mentum* or chin, generally straight at the base, rounded at the sides in front, and deeply emarginate, sometimes with a projection or tooth in the centre, which is often again notched; attached to this is the *ligula*, the representative of the *lingua*, or tongue. Beetles have no true, free tongue, such as is possessed by the crickets. In some—as the Dor Beetle, for instance—it is fleshy and partly free, but in the GEODEPHAGA it is attached to the labium, and forms, in fact, its inner surface. To the base of the ligula is attached a pair of *palpi* of four joints, and at its sides are a pair of pieces called *Paraglossæ*, but in a great many cases the *Paraglossæ* are cemented to the sides of the ligula, so that they are merged into it; they may be considered as a part of the tongue. These altogether constitute the labium, or lower lip.

Immediately under the labrum are the mandibles—a pair of

hooked jaws articulated at their bases to the sides of the head, and worked by powerful muscles. They are of various forms, but those in the examples selected are as typical as any. It will be noticed that the mandibles are not alike, the one on the left-hand side being longer than that on the right; also, that the right-hand mandible has a deep notch at about half way down, whilst the other has only a very small notch near the bottom (see *f.f.*, in Fig. 9). The use of these notches is evident; they act, in fact, like a pair of garden-shears, where the notch in one blade holds the branch or other material whilst the other shears it off. The tips of the mandibles act more like canine teeth. The mandibles are always strengthened by being very much thickened towards their outer sides, and their cutting-edges are tipped with specially hard chitine.

Under the mandibles is the other pair of jaws, or *maxillæ*, composed of several parts: first, the *cardo*, or hinge, attached to which is the *stipes*, or stalk, and the *palpifer*, which carries the *palpi*, composed of four joints, and on its inner side the inner *palpiform lobe*, which is like a palpus of two joints. Here we have the distinctive character of the section ADEPHAGA. In all other sections, although variously modified, this lobe is not of a palpiform shape, and is more or less clothed with bristles, so as to look like a brush. Also attached to the *stipes* is the *lacinia*, or blade, terminating in a sharp hook. This blade is always fringed with a series of bristles, the use of which seems to be to prevent the escape of the food from the mouth sideways during the process of mastication.

It may be useful to superficially examine the mouth of one of the *Brachelytra* by way of contrast, and for this purpose I think "*Ocypus olens*" or "The Devil's Coach-horse" (Figs. 10, 11, and 12), a very suitable example, as it is typical of the section and is a carnivorous beetle. It will be noticed that the inner palpiform lobe (*g.g.*, Fig. 12), which is the distinctive feature of the *Geodephaga*, is here much shortened, and becomes a compact brush. This is the most important characteristic, but there are many other points of interest, such as the large, square, flat head, deeply-cleft labrum, straight mentum, without any emargination or tooth, emarginate ligula, short palpi, and long hooked mandibles, which

give it quite a different character to the *Geodephaga*. The mandibles (*f.f.*) are worth looking at, to notice the processes on the inside of each, some distance below the tip. These, it will be observed, are not alike on each mandible, but a projection in one works into a hollow in the other, acting in effect like molar teeth, so that with the points of the mandibles as they pass each other, acting like canine teeth, the insect has very much the advantages which the higher animals have from a complete set of teeth. Another feature is the brushes attached to the root of the mandibles on the inside. This we do not meet with in the *Geodephaga*. Perhaps owing to the mouth being wider and not so much enclosed as the *Geodephaga*, these brushes are needed to help sweep the food into the centre, and prevent it slipping away.

The British GEODEPHAGA consist of 312 species, divided, according to Herbert Cox's Handbook, into 61 genera. I mention and give prominence to this book, because, before it was published, we had no means of finding the names of beetles except by consulting and comparing the works of foreign authors, books which are quite unattainable to most of us, and require, when obtained, a knowledge of at least six languages to read them. It is true, there are "Stephens' Entomology" and his "Manual"; also Curtis's great work. But these for determining species are so full of error, and so many species have been discovered since their publication, that they are nearly useless.

It will be seen by the chart of the classification of the British GEODEPHAGA given on the opposite page, that the GEODEPHAGA is divided into two families—the *Cicindelidæ* and the *Carabidæ*. The first, or Tiger Beetles, is represented in this country by only one genus, *Cicindela*, of which there are four species. They are very beautiful and most interesting, and have a well-marked distinctive character, namely—the hooked top to the blade of the maxillæ, which is rigid in all the rest of the GEODEPHAGA, whilst in this family it is moveable. The mandibles, too, are very remarkable. The drawings (Figs. 13 and 14, and 15) will explain their peculiarities better than any written description, and I think will prove that any insect would have but a poor chance of escape when once between such jaws, particularly as these beetles are very active, running and flying with great rapidity.

GEODEPHAGA	Cicindelidae			Cicindela, Lin.	4
	Carabidae	ELAPHRIDES		Notiophilus, Dumer.	6
				Elaphrus, Fab.	4
				Blethisa, Bon.	1
		CARABIDES		Cychrus, Fab.	1
				Carabus, Lin.	12
				Calosoma, Weber.	2
				Nebria, Latr.	4
				Pelophila, Dej.	1
				Leistus, Froehl.	5
		SCARITIDES		Clivina, Latr.	2
				Dyschirius, Bon.	10
		BRACHINIDES		Brachinus, Weber.	3
		LEBIIDES	DRYPTIDEA	Drypta, Fab.	1
				Polystichus, Bon.	1
				Odacantha, Payk.	1
			LEBIIDEA	Aëtophorus, Sch.-Goe.	1
				Demetrias, Bon.	2
				Dromius, Bon.	11
				Blechrus, Motsch.	1
				Metabletus, Sch.-Goe.	3
				Lionychus, Wissm.	1
				Cymindis, Latr.	2
				Lebia, Latr.	5
				Masoreus, Dej.	1
		HARPALIDES	LORICERIDEA	Loricera, Latr.	1
			PANAGAEIDEA	Panagaeus, Latr.	2
			CHLAENIIDEA	Callistus, Bon.	1
				Chlaenius, Bon.	4
				Oodes, Bon.	1
			LICINIDEA	Licinus, Latr.	2
				Badister, Clairv.	4
			BROSCIDEA	Broscus, Panz.	1
				Miscodera, Eschsch.	1
			PTEROSTICHIDEA	Sphodrus, Clairv.	1
				Pristonychus, Dej.	1
				Calathus, Bon.	7
				Taphria, Bon.	1
				Anchomenus, Er.	21
				Olisthopus, Dej.	1
				Stomis, Clairv.	1
				Platyderus, Steph.	1
				Pterostichus, Er.	22
				Amara, Bon.	26
				Zabrus, Clairv.	1
			HARPALIDEA	Diachromus, Er.	1
				Dichirotrichus, Duv.	2
				Anisodactylus, Dej.	2
				Harpalus, Latr.	30
				Stenolophus, Er.	11
				Bradycellus, Er.	7
			POGONIDEA	Patrobus, Dej.	3
				Pogonus, Dej.	3
			TRECHIDEA	Trechus, Clairv.	9
				Aëpus, Leach.	2
				Perileptus, Schaum.	1
		BEMBIDIIDES		Lymnaeum, Steph.	1
				Cillenus, Curt.	1
				Tachys, Ziegl.	4
				Bembidium, Latr.	48
				Tachypus, Meg.	2

Genera, 61; Species, 312

The *Carabidæ* is divided into seven sub-families, all of which have their special peculiarities. It would occupy too much space to attempt to enumerate them, I will, therefore, point out a few prominent examples, which seem to possess marked characteristics. The *Elaphrides* are little highly-polished gems, which run very actively in the sunshine, generally near water. The common *Carabus* is, as the name implies, an example of the next sub-family; but there is another which we must notice, namely—*Cychrus rostratus*, or the Beaked Beetle. Its peculiarity consists in the great elongation of the mouth-organs as well as the special form of each organ individually (Figs. 16 and 17). The bi-lobed labrum, the long hooked and three-toothed mandibles, the bi-lobed mentum without any tooth in the centre, and very remarkable palpi, distinguish it at once from all other British beetles. *Leistus* is another genus which is interesting. If we look at the underside of the head (Fig. 18), we notice that the outer edges of the maxillæ are set with spines recurving inwards, and that the mentum and sub-mentum are also set with spines so as to form a complete *cheveaux de frise*. The ligula, too, is peculiar, being a trident, and the very long, attenuated palpi are worthy of notice.

The *Scaritides* (Figs. 19 and 20) are small beetles, which burrcw a good deal in the earth and sand. Their general form is peculiar, being very cylindrical, with the thorax not joined closely to the abdomen. The legs are very short, the front pair being very powerful, having the tibiæ constructed for digging, the tarsi being very small. The mouth, too, has some peculiarities, such as the toothed mandibles (*a.a.*, Fig. 20), which are dissimilar, and interlock one into the other when closed, and the very large fusiform terminal joint of the palpi.

Brachinus crepitans (Fig. 21) is of rather a peculiar form, having the elytra truncated posteriorly, and not covering the abdomen; hence its name. But it has, perhaps, more interest from its having the power of ejecting from its anus a liquid which volatilises on reaching the air, from which fact it is called the Bombardier. This practice is resorted to as a means of defence, for when pursued by another insect it fires off its artillery, which generally so dismays its enemy that it is able to reach some crack or place of shelter in safety.

The genus *Dromius*, or runners (Fig. 22), is an example of the next sub-family, their principal peculiarities being the abbreviated elytra, like *Brachinus*, and their very flat form. This fits them to live under the bark of various trees, their thinness enabling them to insinuate themselves into very small spaces in pursuit of the sub-cutaneous larvæ on which they subsist.

The next sub-family, the *Harpalides*, is very vast, and comprises a great many dissimilar forms; but *Anisodactylus binotatus* (Fig. 23) is a very good general example. It is of a more robust form than any we have previously noticed. The genus *Harpalus*, containing thirty species, are all of this character; so also is the genus *Amara*, containing twenty-six species, all bright, shining little beetles, commonly called "sunshiners," on account of their running about on pathways with great activity in the brightest sunshine. They are very difficult to determine, being so much alike. It is worthy of notice that those beetles which are active by day are usually bright and shining, bronze, green, or blue; whereas those that prowl about by night, and during the day hide under stones and such-like places are generally black and dull. The modern genus, *Pterostichus*, contains twenty-two species, some of which are very common, and is interesting on account of its being originally divided into eight distinct genera; now, however, they are all put together. This grouping doubtless has its advantages, but it certainly brings together very dissimilar forms.

A small beetle, *Stomis pumicatus*, which belongs to this sub-family, has rather singular mouth-organs, having the mandibles much elongated, the right one being notched and very much hooked at the tip, whilst the left is much straighter and without any notch (Fig. 24). They are both curved downwards, like the blades of scissors used for clipping horses. There are a great many more interesting forms, but we will pass on to the last sub-family, the *Bembidiides*. These are all small beetles, the largest being about one quarter of an inch in length, whereas one, *Tachys bistriatus*, is only one sixteenth of an inch long, and is the smallest of the British *Geodephaga*. They may all be known at a glance by the palpi, the penultimate joint being very large, and the last joint small, looking very much like a shoemaker's awl stuck in its handle (see Fig. 25).

The Antennæ do not exhibit any striking variety; they are all eleven-jointed and simple in character. The Claws are generally simple, but in some cases they are toothed on the inside. The genera *Demetrias*, *Calathus*, *Pristonychus*, and *Taphria* are instances of this peculiarity (see Fig. 26). There is an important characteristic possessed by all the *Geodephaga*, except the section *Cicindelidæ* and the sub-sections *Elaphrides* and *Carabides*. I refer to the hollow on the inside of the anterior tibiæ (Fig. 26). This is of peculiar form, being placed obliquely, and furnished with comb-like bristles. One of the large spines which is usually found at the tip of the tibiæ is set at the root of the hollow; a friend has suggested that this remarkable organ may be for cleaning the antennæ, and although I have not been able to prove it, I think it is very likely that such is the case. A similar arrangement exists in the *Hymenoptera*, but in this case the hollow is in the first joint of the tarsus. It is well shown in the foot of the common wasp.

In "Westwood" I find the following note:—"Mr. Curties has noticed an interesting peculiarity in the anterior tibiæ of the genus *Cillenum*, which are not only armed with the two ordinary spurs (one above and the other below the notch), but have, also, two additional deflexed spines at the outer extremity of the notch, between which spines, he presumes, the lower moveable spur is received; hence he conceives that these notched anterior legs of the *Carabidæ* are used in seizing and retaining their prey, for the limb of an insect being received into the notch, and the lower moveable spur being pressed upon it, the insect would be effectually secured." It is quite possible that in this particular genus it *may* have this use, although I very much doubt it; but in the numerous other genera it is obviously of a character unsuited for this purpose. Its oblique direction, and the fringe of bristly hairs, something between a comb and a brush, together with the curved, hair-like spines, which close over the hollow like a spring, all show, I think, an adaptation to a use, such as drawing the antennæ through to cleanse them from dust and dirt. The Humble Bees possess this notch, and use it for the purpose of a pair of nippers; also, the Carder Bees use it for hackling the moss with which they build their nests. In these instances the form of the notch is

very different, besides possessing the blade which shuts down upon it like the blade of a pocket-knife.

The remaining characteristics to which I wish to direct attention are entirely sexual. Very nearly all the males have the joints of the anterior tarsi dilated in some way or other (see Fig. 27). The few examples shown in the drawings exhibit some of the more general forms of these dilated joints, but there is a great deal of variety in the different genera, some being square, others triangular or heart-shaped; whilst in others we find one, two, three, or four joints modified in this way. Again, the genera *Anisodactylus* and *Harpalus* have both the anterior and intermediate tarsi dilated, the use of which is, beyond dispute, to enable the male to grasp the female; those that are not thus provided seem to have an equivalent in some other organ. A reference to the drawing of the head of *Cychrus rostratus* (Figs. 16 and 17) will show the enormous spoon-shaped palpi of the male compared with those of the female, which are evidently used for the purpose suggested.

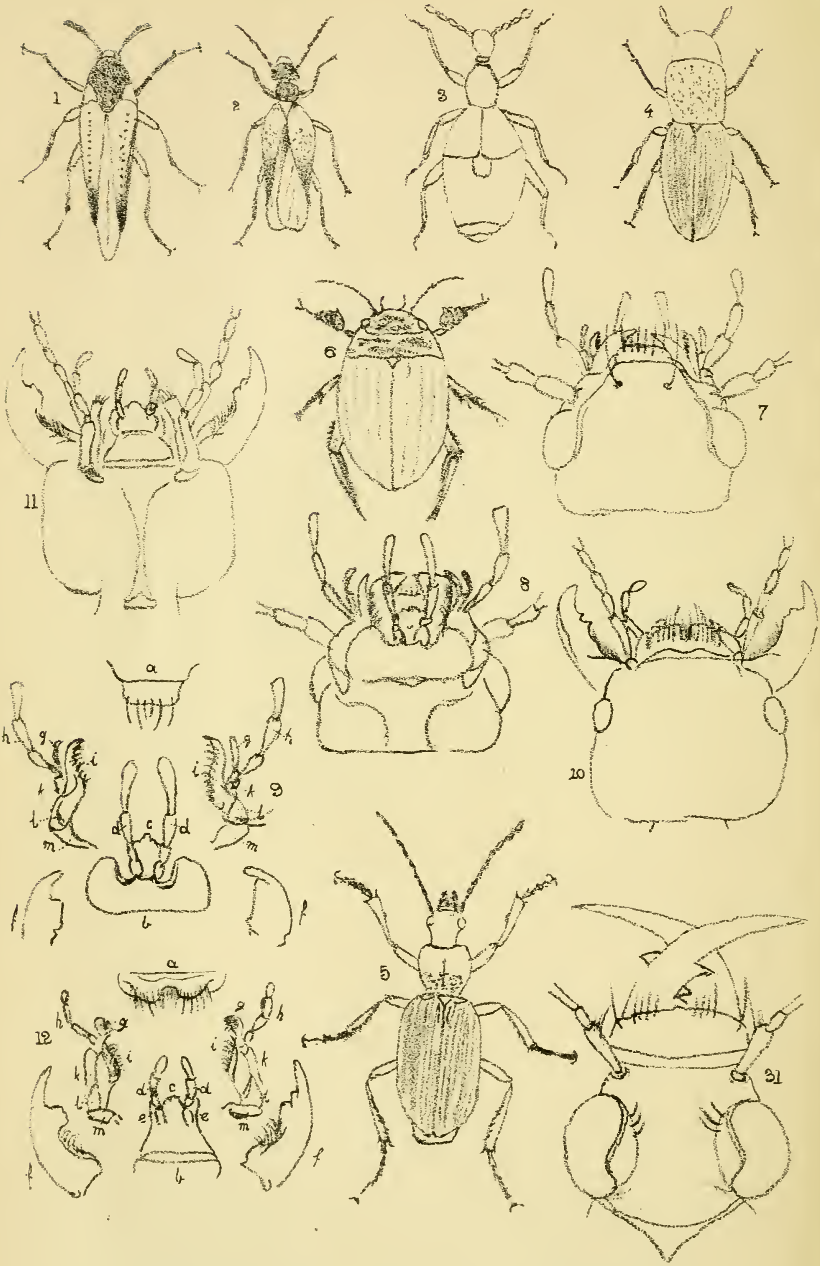
There is yet another point, namely—the very peculiar appendages attached to the under side of these dilated joints, which are called tenent hairs (Fig. 30). These hairs are very remarkable in form, suddenly swelling out at the tip; trumpet-shaped nearly describes their form, only with this difference, that a trumpet is round, whereas these hairs terminate in a much-flattened ellipse, and seem to be hollow, suggestive of a sucker. They are placed in rows on each side of the tarsi joints; their number and exact form differ in various genera and species. Good examples are shown in the drawings (Figs. 28—32). The hairs act, undoubtedly, as organs of prehension. It may be by their exuding a peculiar sticky fluid, particularly at the time of union of the sexes, or they may act more as suckers, or both functions may have something to do with it. I have been unable to find any information respecting these hairs in any work that I have had access to, except in a paper read before the Linnæan Society in 1861, by Mr. Tuffen West. I find his observations exactly correspond with my own. Connection is also assisted in some genera—*Harpalus*, for instance—by the females having their elytra granulated and rough, instead of highly polished, as those of the males.

In some of the Water Beetles this is carried still farther, the females having their elytra deeply sulcated, as in the genus *Dytiscus*, and grooved and hairy in *Acilius*. We see how very important this is when we remember that insects, unlike the higher animals, unite but once only; the male dying very shortly after, whilst the female lives on until she has deposited all her eggs. Nature has provided a receptacle called the spermatheca, in which the seminal fluid of the male is stored up, and it is so arranged as to fertilise each egg before it is deposited. The celebrated John Hunter actually succeeded in fertilising the eggs of a female beetle which had not been in connection with the male, by touching them with the fluid which he found in the spermatheca of another female.

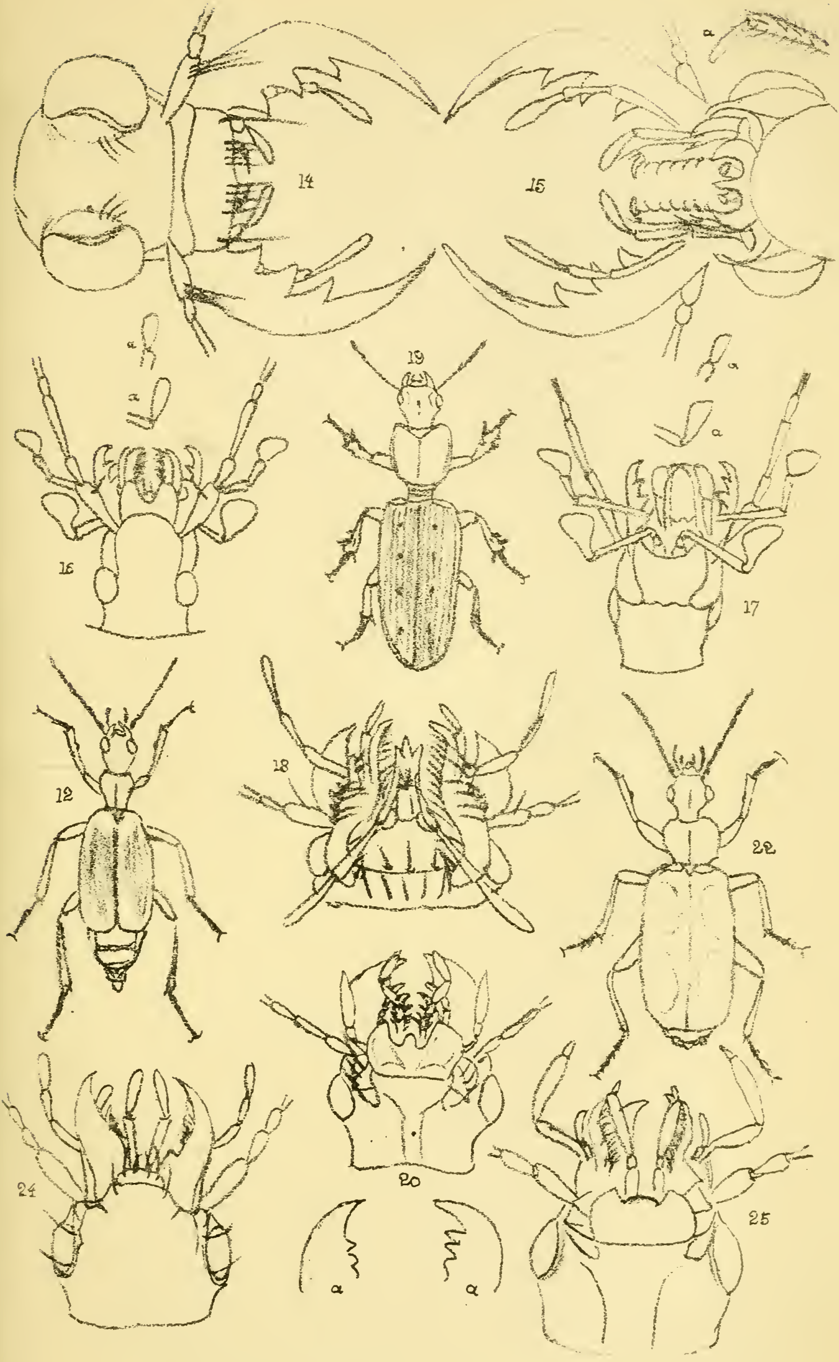
I have tried to point out some of the most important features, as they appear to me, in those beetles of the section *Geodephaga*, which I have had the opportunity of examining. Much more might have been written, and doubtless there are many other species which would have proved quite as interesting, or even more so than those I have chosen. In another paper I hope to describe the Larvæ of Beetles, and also to contrast the form of the mouth-organs in the Carnivorous Beetles with those of the Vegetable and the Dung-feeding species.

EXPLANATION OF PLATES I., II., III.

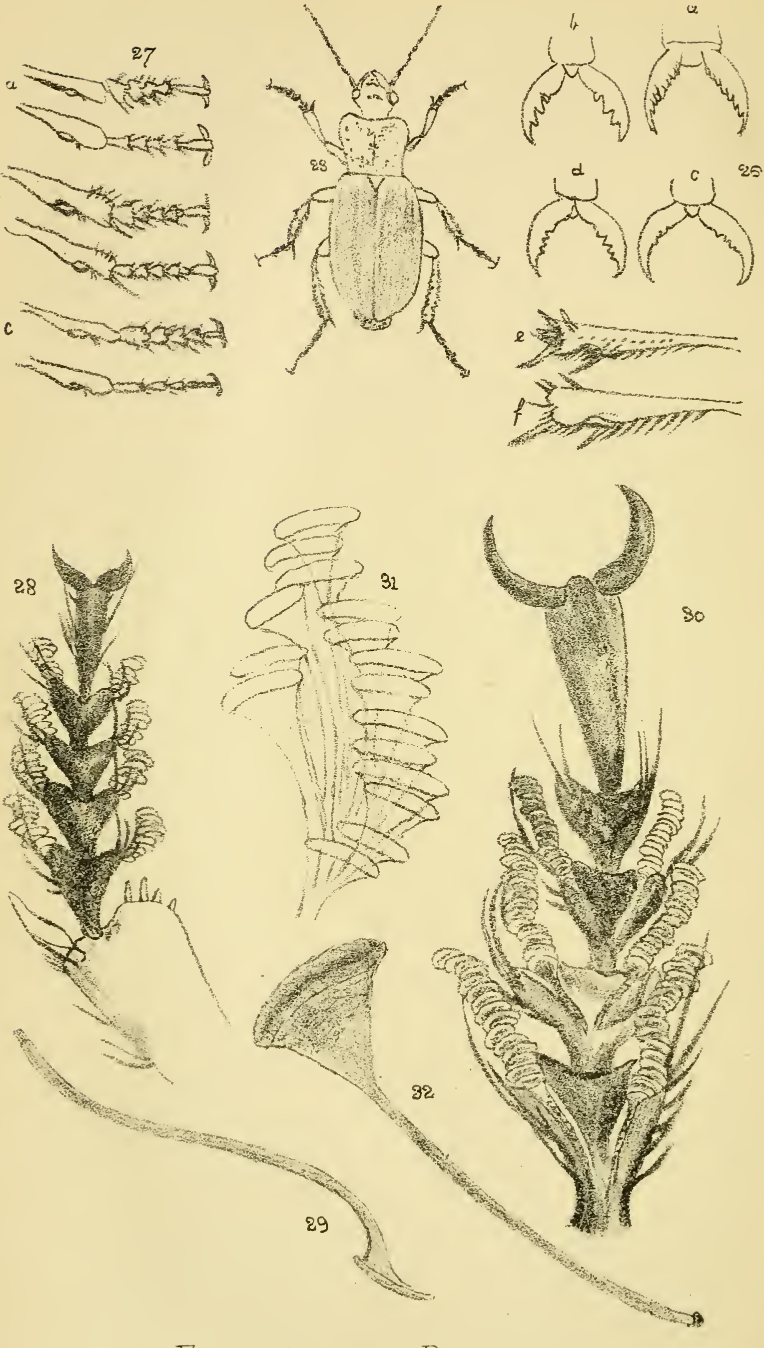
Fig. 1.—*Metœcus paradoxus*, ♀ ; length, one-third of an inch.
,, 2.—*Sitaris muralis ;* length, half an inch.
,, 3.—*Claviger foveolatus ;* length, one-twelfth of an inch.
,, 4.—*Anommatus duodecim-striatus ;* length, one-sixteenth of an inch.
,, 5.—*Anchomenus albipes*, ♀ ; length, three and a-half lines.
,, 6.—*Acilius sulcatus*, ♂ ; length, five-eighths of an inch.
,, 7.—Mouth-organs of *Nebria brevicollis*, dorsal view.
,, 8.—Ditto ditto ventral view.



Mouths &c. of the Geodephaga.



Mouths &c. of the Geodephaga.



Feet &c. of Beetles.

Fig. 9.—The same, dissected.

a, Labrum, or lower lip.

b, Mentum, or chin ; to which are attached—*c*, Ligula, or tongue ; *d.d*, Labial palpi ; *b* to *d* together constitute the Lower lip ; *f.f*, Mandibles ; *g*, Inner or Palpiform lobes ; *h*, Maxillary palpus ; *i*, Lacinia, or blade ; *k*, Palpifer ; *l*, Stipes, or stalk ; *m*, Cardo, or hinge ; *g* to *m* together constitute the Maxillæ. In this insect the Paraglossæ are not largely developed, and do not show in the drawing.

,, 10.—Mouth-organs of *Ocypus olens ;* dorsal view.

,, 11.—Ditto ditto ventral view.

,, 12.—The same, dissected.

a, Labrum, or upper lip ; *b*, Mentum, or chin ; *c*, Ligula, or tongue ; *d.d*, Labial palpi ; *e.e*, Paraglossæ ; *b* to *e* together constitute the Labium, or lower lip ; *f.f*, Mandibles ; *g*, Inner or Palpiform lobe; *h*, Maxillary palpus ; *i*, Lacinia, or blade ; *k*, Palpifer ; *l*, Stipes, or stalk ; *m*, Cardo, or hinge ; *g* to *m* together constitute the Maxillæ.

,, 13.—Mouth-organs of *Cicindela maritima*, dorsal view ; mouth closed as in repose.

,, 14.—Ditto, open.

,, 15.—Ditto, ventral view ; the labial palpi have been removed to show organs underneath. One of the labial palpi is shown at *a*.

,, 16.—Mouth-organs of *Cychrus rostratus*, ♂, dorsal view; the Palpi of the female are shown at *a a*.

,, 17.—Ditto, ventral view. The Palpi of the female are shown, at *a.a*.

,, 18.—Mouth-organs of *Leistrus spinibarbis ;* ventral view.

,, 19.—*Clivina fossor ;* length, one quarter of an inch.

,, 20.—Mouth-organs of *Clivina fossor ;* ventral view. *a.a*, Mandibles.

,, 21.—*Brachinus crepitans*, the Bombardier Beetle; length, one-third of an inch.

,, 22.—*Dromius quadrimaculatus ;* length, two and a quarter lines.

,, 23.—*Anisodactylus binotatus*, ♂ ; length, five lines.

,, 24.—Mouth-organs of *Stomis pumicatus*, dorsal view.

,, 25.—Mouth-organs of *Bembidium littorale.*

,, 26.—Toothed Claws of—*a*, *Calathus ;* *b*, *Demetrias ;* *c*, *Pristonychus ;* and *d*, *Taphria*. Notched Anterior Tibiæ :—*e*, Right tibia, ventral view ; *f*, Left tibia, dorsal view.

,, 27.—Anterior Tarsi of the Males and Females, compared in—*a*, *Loricera ;* *b*, *Harpalus ;* and *c*, *Bembidium*.

,, 28.—Leg of *Amara communis*, ♂, × 50.

,, 29.—One of the appendages (tenent hairs) in profile, × 300.

,, 30.—Leg of *Pterostichus niger*, ♂, × 25.

Fig. 31.—View of some of the appendages (vesicles), × 100.
,, 32.—One of these still more enlarged, × 200.

Figures 28—32 are after Tuffen West; the others are drawn from nature by Robert Gillo.

A Letter from Maori-Land.

By Thomas Steel,

Auckland, New Zealand,

Corresponding Member Greenock Natural History Society.

Plate IV.

THE land of the Maori and the Moa had long been to us a kind of scientific *El Dorado;* a land teeming with all manner of strange and weird objects of the natural world, a very antipode to all that we had been accustomed to at home, and stranger even than that land of strangeness, Australia. It was natural, therefore, that we should have looked forward with joyful anticipations when it fell to our lot to go to the storehouse of the new and the wonderful, and we are glad to say that our experience of New Zealand has quite come up to our expectations. Before coming here, we were told that we were going to a beautiful and delightful country, and certainly that portion of New Zealand which we have seen has fully sustained the *prestige* which the designation, "Land of Loveliness," would lead us to expect. The climate of Auckland is almost a perpetual springtime, and has been described by those who have travelled much as being not often equalled, and perhaps never surpassed, by that of any other portion of the world.

The province of Auckland, in the north island of New Zealand, has been called "The Wonderland of the World," and it certainly does possess a full share of those curious objects which are so great an attraction alike to the scientific and unscientific.

It is not our intention to dwell so much on what are perhaps the more generally attractive features of that portion of the land which we have had opportunities of inspecting, as to speak of some of the more striking natural history objects, which, by their contrast with what we have previously experienced, naturally attract our first attention, and are more likely to prove of interest to our old friends at home. Many people have remarked that the country around the city of Auckland bears a very striking resemblance to home scenes. By home we of course mean the old country, and it is curious how people out here, even though born and brought up in the colonies, invariably speak of the mother country as home!

Persons going by road or rail to one or other of the charming little villages in the vicinity of Auckland might very easily imagine themselves to be in some of our Scottish country districts, for the aspect of the land is certainly more Scotch than otherwise. Indeed, going by rail from Auckland to the suburban village of Remuera, the scenery bears a startling resemblance to that with which we are so familiar between Greenock and Kilmalcolm.

On either side of the line are the farm-yards, with their fields fenced in with hawthorn, and the national Scotch "Dry-stone Dyke"; on every side are vast quantities of the golden blossoms of the yellow whin bushes, which here attain a luxuriance of growth seldom surpassed even on the bonny hills of Renfrewshire, and which, when in all their glory of bright-coloured blossom, well seem to merit the tribute paid to them by the great Linnæus. At frequent intervals are "plantings" of Scotch and American firs; while scattered everywhere are poplars, oaks, and other familiar trees, to say nothing of the hosts of docks, thistles, and other weeds, which, having found a congenial home, have flourished apace.

The native trees and plants are quite in the minority; for one New Zealand plant we find dozens of foreigners. Still, those native plants which do flourish side by side with their imported rivals have about them such a stamp of originality as to prevent us losing sight of the fact that we are indeed in the home of a strange flora. By their mere individuality, the native trees are so striking in appearance that they at once attract and rivet atten-

tion, and were it not that the home plants are so familiar and well known to us, we should certainly pass them over almost unnoticed in favour of the quaint and curious natives. Nothing could, for instance, be more pleasing and attractive to the eye than the bold outline of a hillside against the sky, crowned with a feathery ridge of the graceful cabbage-tree (*Cordyline Banksii).* This curious tree is to our mind the perfection of gracefulness. The trunk is slender and clean, and rises straight upwards for from 10 to 15 feet, though many trees attain much larger dimensions; it then strikes into several equal short branches, which in their turn again equally subdivide; each branch bears a clump of strong, rush-like leaves, which expand in all directions. Occasionally, several trunks spring from one root, but more commonly there is one stem only. The blossoms appear about December, and being very full of nectar prove a great attraction to various birds and insects. Several species of this genus are found in Australia, and are popularly known as "lily palms." The general appearance of the New Zealand cabbage-tree reminds us of the common Australian screw-pine, *Pandanus pedunculatus* (R. Brown), the generic name of which is derived from a Malay word, meaning "conspicuous."

The New Zealand flax, *Phormium tenax*, is a very useful plant, and forms quite a feature in our New Zealand scenery, and takes a high place as an article of commercial value; it is only found in New Zealand, and grows freely in all localities. The plants of flax generally grow in clusters or groups, and sometimes large stretches of land are densely covered with them. In appearance they are like huge flags; the long, broad, grass-like leaves making the plant very conspicuous. The flowers are produced on long stalks, not unlike those of the aloe, and are so full of nectar, as quite to overflow with it, and the natives used formerly to collect the sweet secretion as an article of food. We do not remember to have seen any plant which can at all compare with the *Phormium* in the abundance of this secretion. The great value of the *Phormium tenax* consists in its being a fibre producer. The leaves are excessively strong, and are very largely used for making the fibre known in commerce as New Zealand flax. The Maori have long used the leaves for a great variety of

purposes, and a multitude of articles, from cloth and ropes, to the walls of their huts, are or were made from it.

Any mention of New Zealand plants would be quite incomplete without reference to that noble native tree, the Kauri gum, *Dammara Australis* (Lambert). This splendid tree is at once the monarch and the chief glory of the New Zealand forest. It grows to an enormous height, 150 feet being frequently reached, the circumference being commonly 30 feet. Logs of 60 feet are often cut. Mr. Griffin alludes to one tree on Totamoe Mountains, the trunk of which is 66 feet in circumference or 22 feet in diameter. The Kauri tree is exclusively confined to the northern portion of the North Island, being found nowhere else. The trunk is a beautiful clean column, crowned with a graceful head of dense foliage. The leaves are short and flat, and the cones are very small in proportion to the size of the tree. When a notch is cut in the bark, the semi-liquid gum exudes, exactly as in the case of the pine tree. The gum quickly hardens by exposure; when fresh, it has an aromatic taste, and is largely used by young people as a kind of sweetmeat. It appears to be formed in large masses in or about the roots of the trees, and all the Kauri gum of commerce is obtained by digging it out of the earth at those places where years before the trees have lived and died. There is some mystery about the ultimate destination of the gum, but the great bulk of it is exported to America, where it is used as an ingredient in the preparation of varnish. We suppose, also, that a portion finds its way into commerce as Gum Dammar.

The Kauri tree sheds its bark and branches in a curious manner. The branches and twigs die and drop clean off, leaving a regular scar exactly similar to that left by the petiole when ordinary trees shed their leaves. The bark is shed, not in irregular pieces, but in what we can term nothing else than regular scales. These flakes, or scales, of bark become detached all round, and then drop off; they strongly remind us of the scales of a fish. It is, however, as a timber tree that the Kauri stands unexcelled.

The wood is almost exclusively used in New Zealand for all manner of outdoor and indoor work, it takes a beautiful polish, more especially in the knotty parts, and is suitable for cabinet and other fine work.

Owing to the great demand for the timber, the Kauri trees are rapidly diminishing in number, and though in the less accessible mountain districts there are still magnificent Kauri forests, still we cannot but think that if strong measures are not put in force, and that soon, the Queen of the New Zealand forest will at no distant date take its place, with the Moa, among the things that have been. Truly, it would be a great pity if such a thing should occur. We have lost the Moa; let us preserve the Kauri and the Kiwi!

The large trees of the New Zealand forest have to contend with a multitude of climbing and parasitic plants. Everywhere one sees huge trees quite smothered under a load of vegetation, or else lying dead and prostrate, having broken down under the weight of their uninvited burthen. The Lawyer vines (*Calamus)* of the Australian scrubs are here represented by the New Zealand Raspberry vine, *Rubus Australis*, a plant having much the same habit as its Australian counterpart, but not being so formidably armed. We have also the curious Supple Jack (*Rhipigonum scandens*), a trailing climber, which well deserves its title.

The approach of Christmas is heralded here, not by frost and snow, as in the dear old country, but by sunshine and flowers, by the blossoming of all manner of bright and glowing plants and by the ripening of delicious fruits. But the herald of the joyful season, *par excellence*, to us is the breaking out in glorious profusion of blossom of the magnificent Pokutukawa, or Christmas Tree (*Metrosideros tomentosa*). This is a large, dark-foliaged tree, which grows profusely about Auckland, more especially along the coast. When not in bloom it is a sombre-looking tree, though graceful and ornamental, but when in the full glory of blossom it is truly a splendid object. The flowers are clusters of little groups of bells, three bells in each group; the calyx is thick, fleshy, and cup-shaped; the petals are very small and rudimentary, while the stamens are long and of a brilliant crimson colour, and it is to them that the tree when in flower owes its singular beauty. The flower-cups are full of nectar, each containing a large drop. It is fertilised by the birds, which come to feed on the nectar, and in so doing get the pollen from the long, stiff stamens on their feathers. A large Christmas tree in full blossom

is like a huge crimson fire, and is a sight not soon to be forgotten.

Nowhere, perhaps, in the world is there to be found such a profusion of ferns of all sorts and sizes, as in the damp, sheltered nooks of the New Zealand forests. Most conspicuous amongst them are the graceful Tree-ferns, great fellows towering to the height of 20 and 30 feet, and at the same time looking so delicate and airy that one almost fancies it possible to take one on each shoulder and walk off with them.

Climbing ferns are here found in great profusion, and of these one of the commonest, yet most curious, is *Polypodium serpens* (Foist), the barren fronds of which are quite round, while the fertile ones are long, and both are entire and fleshy. They are covered with a dense coating of beautiful stellate hairs, and are most interesting under the microscope. We are all familiar with stellate hairs in many plants, but it is somewhat unusual to meet with them in the fern tribe. *P. serpens* is also found abundantly in Queensland.

Polypodium Billiardari (Brown) is another very pretty climbing fern, having a thick, fleshy, creeping rhizome, and whose sections prove quite a treat for the microscopist, it being just of the right firmness of structure to cut into sections, and presenting under the instrument a most curious structure. It is a common fern, climbing over trees and rocks everywhere.

We admire exceedingly some of the larger Lycopods, and we would like to speak more about them and the multitude of other beautiful plants which abound here; but we have many other topics on which we wish to dwell, and so are reluctantly compelled to turn away from these charming Flora. A convenient object to utilise as a stepping-stone between the consideration of the plant and the animal worlds, is the very curious organism known as the New Zealand "Vegetable Caterpillar." Though but an exaggerated example of a very common species of parasiticism, this object is sufficiently strange to warrant more than a passing glance. The caterpillar is the larva of a moth, *Hepialus virecens* (Roberts), and feeds upon the leaves of a tree.

Before changing into the chrysalis, the caterpillar buries itself in the earth, and it is then that the curious phenomenon of which we are now speaking takes place. About the month of March, in

places where these caterpillars are found, may be seen slender, brown, spear-like stems, a few inches in length, projecting from the ground. On digging them up, we find that they proceed from the body of a caterpillar. These spikes are the bearers of the spores of a fungus, the mycelium of which completely fills the body of the caterpillar. On examination we find that the fungus has completely replaced, with a dense, corky mass of mycelium, all the internal organs of the caterpillar, though externally there is nothing to indicate this, the skin of the insect being quite unchanged and retaining its natural shape. The manner in which the caterpillar becomes infected with the spores of the fungus is not exactly known, but it is probable that they are either eaten adhering to the leaves which form the food of the insect, or else that they enter by the spiracles in the manner so well known in the insect world. The name of the fungus is *Cordyceps Robertsii* (Berk). The drawing (Pl. IV.) will give an idea of the appearance of this specimen. Similar organisms are, I understand, found in Queensland, India, and China. In *Nature*, Vol. XIV., p. 224, is a notice of a specimen from Queensland being exhibited at a meeting of the Entomological Society of London; and I think there is mention somewhere in the Transactions of the Geological Society of Glasgow of a specimen from India being exhibited at a meeting of that Society by Mr. John Young. A curious circumstance in connection with New Zealand is that though rich in plants which secrete a great abundance of nectar there are no indigenous bees. There are also no snakes, though lizards are abundant, and a frog is also native to the country. The absence of snakes is striking when we consider that all the adjacent lands have them in abundance: Australia, Tasmania, and Fiji all have snakes. The well-known absence of reptiles from Ireland is analogous, but it is curious that we in New Zealand should have other kinds of reptiles, but no snakes. It has been given as a joking reason for their absence from the Green Isle that it was such a forsaken spot that even a snake would not stop in it; this cannot be said of New Zealand, it is much too lovely a land for that; indeed, we might carry the joke a little further, and say that New Zealand was such a beautiful land that snakes had not the presumption to enter!

Perhaps the most singular of New Zealand reptiles is the well-known Tantara lizard, *Sphenodon punctatum* (Gray). This lizard has long been an object of interest to naturalists from the unique position which it occupies amongst living reptiles. It seems that it stands in a position nearer to that of the birds than any other reptile, and that it also serves as a link between the lizards proper and the crocodiles.

It is said that this lizard has the curious habit of living in perfect harmony and in the same burrow with a small tern, the bird occupying one side of the chamber at the end of the burrow and the lizard the other. This is not our experience, for we have found both bird and reptile, but in different burrows. The Tantara lizard is not common, being now found only on some of the islands composing the Barrier group off Auckland. It is a pretty creature, nocturnal in its habits, and is quite harmless. We are informed by people who have camped on the islands where it occurs, that at night it comes crawling about the camp, attracted by the light and the fire, much to the alarm of those who regard all such creatures with aversion.

Of late, our great aim has been the collection of the bones of the Moa, that curious, extinct, wingless bird which has attracted so much attention. There were several species of Moa. Some attained the height of ten feet, whilst others did not exceed three feet. The Moa was hunted by the Maori, and it is about their old camping grounds that we search for the remains of the feast—the dry bones, which, I may safely say, furnish a richer feast to the Pakeha (white man) than did ever the flesh to the old Maori. By carefully searching the sandhills along the Manaia and Patna beaches at Whangarie, we have found many good specimens of different bones of *Dinornis parvus* (Owen), *D. Oweni* (Haast), and of *D. Gracilis* (Owen). It was only the other day that in exploring one of the numerous little caves in one of the lava fields near Auckland, that we came on a skeleton of *D. Oweni* in a fair state of preservation. It was very interesting to find the curious calcareous rings of the throat lying beside the neck vertebræ, and the other bones in their natural position. The Moa seems to have had a habit of retiring to the dark recesses of caves and holes to die, and to this habit science owes some of the

finest specimens which have been found. The food of the Moa seems to have been entirely of a vegetable nature, and small pebbles were swallowed to aid in the grinding of the food.

Another of the characteristic birds of New Zealand which seems doomed to follow its relative the Moa and become a thing of the past, is the pretty little Kiwi, *Apteryx Manteli* (Bart). This bird is still moderately common in the more secluded mountain forests, but not having the power of flight, and being entirely dependent on its acute senses for safety, it is gradually becoming rarer. We have had the pleasure of minutely inspecting several fresh specimens. The wings are exceedingly rudimentary, being merely little naked stumps, and are entirely concealed beneath the dense covering of long, hair-like feathers. The legs are strong and heavy, the beak is long and slender, having the nostrils at the tip. We have seen birds infested with large numbers of parasites, but we think we have never seen one so overwhelmed with them as the poor little Kiwi. A species of mite *(Acarus)* is found about the shafts of the feathers, literally in myriads. After the bird is killed, they come crawling in writhing masses on to the ends of the feathers, and so excessively numerous are they, that the feathers are quite hid beneath the great multitude. Then there are three or four different species of *Ixodes*, or Ticks, the smaller species of which can be counted in dozens, and the larger ticks are nearly as abundant. Truly it is a hard matter to understand how the poor bird manages to exist at all under such a load of blood-suckers. The Kiwi and the Tree-Fern are incorporated in the national arms of New Zealand, and it would be a great pity if such an interesting emblem of a past age, as this bird is, were allowed to die out.

We have but little more to add to this paper. It was our intention to say something about the Maories themselves, regarding whom we have been able to glean much exceedingly interesting information, but we are greatly hampered through want of time. All our leisure is naturally given up to the collection and preservation of the numberless specimens, new to us, which are constantly coming under our observation.

New Zealand "Vegetable Caterpillar"
Caterpillar - Hepialus virescens
Fungus. Cordyceps Robertsii

Fresh-Water Algæ.

Part I.

By George Norman, M.R.C.S., etc.

THE older botanists divided the Cryptogams into Thallogens and Acrogens; the modern German school requires three divisions: Thallophytes, Muscineæ, and Vascular Cryptogams. In either case, the first division, Thallogens or Thallophytes, remains the same, and includes Algæ, Fungi, and Lichens.

The characteristic common to these three groups is the presence of a vegetative body, or Thallus, which exhibits no differentiation into stem, leaf, and root, or, if it does so at all, it is only in a very rudimentary degree.

Without entering into the disputed question of the position the Lichens should assume in this division, we may say, speaking generally, that the Algæ and Fungi form by far the largest and most important section.

About the beginning of this century, little was known about either group, plants being frequently referred to the one which really belonged to the other, and even in the full light of modern investigation there are still genera whose position is extremely doubtful. One point has, however, been brought out by modern investigation, and that is, the slight difference that exists between these groups from a morphological point of view. In consequence, an attempt has been made to arrange Algæ and Fungi together in classes according to the method of reproduction, but this has been only partially successful owing to our ignorance of the details of the life-history.

As to the differences that exist between Algæ and Fungi, the most striking one to all observers is, the presence of chlorophyll in the Algæ and its absence amongst Fungi; and following on this is the difference as to habit and mode of life. The Fungi are adapted to absorb organic carbonaceous nutriment from their surroundings; if they obtain it from living bodies, we have parasitism in its various forms; if they have the capacity of consuming dead organic remains, their habit of life must vary accordingly.

Algæ are able themselves to produce carbonaceous food-materials out of carbonic acid by assimilation; they are not therefore usually either parasites or saprophytes, but can maintain an independent life. Their dependence on assimilation requires that they should inhabit localities where there is free access of light; while Fungi are not absolutely dependent on light for their supply of food.

The Fresh-Water Algæ ought, from a strictly scientific point of view, to be considered in conjunction with the marine Algæ, as they both belong to the same group. The only excuse for considering them apart is that of convenience to those microscopists who desire some acquaintance with the organisms to be found in the numerous ponds and canals of their neighbourhood.

The classification of Algæ, like that of Fungi, is still in a transition state, and for the same reason, viz., that we are as yet unacquainted with the full details of the life-history in many species.

For practical purposes, the classification adopted by Cooke in his recently completed work on the Fresh-Water Algæ answers very well. He mentions that all Algæ are associated under five classes, viz.:—

1.—CHLOROPHYLLOPHYCEÆ, with the cell contents mostly of a chlorophyll-green.

2.—PHYCOCHROMOPHYCEÆ, with the cell contents mostly of a bluish-green.

3.—MELANOPHYCEÆ, with the cell contents olive, brownish, or blackish.

4.—RHODOPHYCEÆ, with the cell contents rosy, purple, crimson, or violet.

5.—DIATOMOPHYCEÆ, with an incombustible siliceous skeleton.

The third class are all marine, and the majority of the fourth, so that, exclusive of diatoms, which are a special study, the Fresh-Water Algæ are mainly included in the first two classes.

The classification proposed by German botanists and accepted by some in this country is made according to the method of reproduction, and is similar to that of the Fungi, viz.:—

1.—PROTOPHYTA, in which the multiplication of individuals is effected by fission of the vegetable cells.

2.—Zygosporeæ, in which two similar cells coalesce and produce a reproductive cell termed a zygospore, which germinates after a longer or shorter period of rest, and gives rise either to spores, or to a plant of the same kind as that in which conjugation took place.

3.—Oosporeæ, in which the two reproductive cells are essentially different. The female cell, or Oosphere, is enclosed within an older cell, the Oogonium. The male cells, the Antherozoids, are enclosed within a larger cell, the Antheridium, and are endowed with motion by means of vibratile cilia. They swarm round the Oosphere and cause its impregnation by the coalescence of their substance with it; the Oosphere becomes invested with a thick cell wall, and is now called the Oospore. After a longer or shorter period of rest, the Oospore germinates, and gives rise either to a plant resembling the mother plant, or to a number of Zoospores, each of which finally gives rise to a plant like the mother plant.

4.—Carposporeæ, in which there is a general resemblance to Oosporeæ, but a great deal more individual variety. The female element consists of one or more cells, and is called the Carpogonium. The male cell varies greatly, consisting of antherozoids either swarming or passively motile, or of tubular pollinodia. Fertilisation is effected by the entrance of antherozoids into the female cell as in the Oosporeæ, and the product is called a Sporocarp. This is sometimes a single cell germinating directly, or through the medium of zoospores, or more generally a multicellular body from which spores are finally produced.

One essential difference between Sporocarps and Oospores consists in this: that in the production of the former certain cells also take part which were not immediately concerned in the act of impregnation; and that the portion of the fructification producing the spores is surrounded by a sterile envelope, which serves merely for protection, or for further nourishment.

There is, however, another method of propagation common to all these four classes—viz., by means of Gonidia, which are produced quite independently of any act of fertilisation. The Gonidia often arise from the Thallus by the whole of the contents of certain cells dividing, and producing two or more Gonidia,

which become detached from the plant. But in other cases special supports or receptacles are formed in the Thallus, the sole function of which is to produce Gonidia, either by the abstriction of the ends of special branches (Stylogonidia), or by free cell formation in the interior of large cells (Endogonidia). The Gonidia, when they escape from the mother cell, possess no cell-wall, and are motile; hence, they are now called Zoogonidia. The anterior end is hyaline, and in some cases a minute red dot lies at one side; two cilia are attached to the anterior end, or to the side, or to both. Sometimes the anterior end is encircled with cilia, or even the entire surface of the Zoogonidium.

During swarming a cell-wall is secreted, the Zoogonidium comes to rest, attaches itself to some body by its anterior end, the cilia disappear, and germination commences, the end which was posterior during swarming now becoming the growing point, and hence the anterior end of the young plant.

It is well to mention here that in some cases swarming cells are seen to conjugate; in this case they cannot be regarded as Zoogonidia, but as motile sexual organs which should be placed in the class Zygosporeæ.

It must not be supposed that all the Fresh-Water Algæ are reproduced exactly according to one or other of the methods now described; on the contrary, although allowing of a general classification under one or other of these heads, there is very great diversity amongst them, the details of which it would be impossible to give within a reasonable length. Taking, however, this classification as a basis, in our next paper, we will glance at some of the principal genera.

The Microscope and how to use it.

By V. A. Latham, Late Hon. Sec. U.J.F.C., Norwich.

Part V.—Double-Staining, etc.

DOUBLE-STAINING is a subject which requires to be very much more worked out than it has been hitherto. There is no pursuit in which patience and time for experimenting

are more required than in that of double-staining. The student must not be discouraged by many failures, as from each there is some new fact to be learned and noted, and in the application of these to future experiments some brilliant results are sure to be obtained. Let us give a hint before going further. Always note the stain, strength of it, the time required for the operation, etc., in a note-book, to be kept specially for that purpose, as it will be found to be of great value. The following are some of the best combinations :—

1.—Picro-Carmine and Logwood.
2.—Picro-Carmine and Safranine.
3.—Picro-Carmine and Iodine Green.
4.—Eosin and Aniline Blue.
5.—Eosin and Logwood,
6.—Eosin and Aniline Green, etc.
7.—Aniline Rose and Aniline Green.
8.—Bismarck Brown and Aniline Green.
9.—Borax Carmine and Indigo Carmine.
10.—Methyl Green and Induline.
11.—Gold Chloride and Anilines.

1.—Picro-Carmine and Logwood.

To Stain Sections of the Scalp, Skin, or Tongue.—Stain the sections first in picro-carmine (10 drops to a watch-glass full of distilled water), let the sections remain in this for from 20 to 30 minutes, then wash in water, place in distilled water acidulated with 1 or 2 drops of acetic or picric acid. Leave for about one hour; then remove and place in dilute logwood stain (5 to 7 drops in a watch-glass of distilled water); *do not let them stain too deeply*. When coloured as required, wash to remove the excess of logwood, and mount in the ordinary way. This is very good when used with fresh tissues, as mucous membranes; it brings out connective tissue corpuscles in the mesentery of a newt, and shows non-striped muscular tissue very well. It is also useful in bringing out delicate tissue in the tubuli seminiferi of the testis, and showing the developing spermatozoa there. Developing bone shows very well.

2.—Picro-Carmine and Safranine.—This is especially applicable where you wish your specimen, owing to its structure, etc., to be very clear and transparent. Stain in picro-carmine first, then with safranine. The former stains all the connective tissue and nuclei, while the latter stains muscle, epithelium, etc.

3.—Picro-Carmine and Iodine Green.—This is one of the most useful combinations of which we know. Stain the sections in picro-carmine, wash well in water slightly acidulated with acetic acid, then stain in a watery solution of iodine green, take care they do not become overstained, which can easily be ascertained by washing them in water. If a section, say of the posterior third of the Tongue, be stained, all the connective tissue and the muscles will be red, whilst the mucous glands and adenoid tissue will be green. The serous glands do *not take up* the green stain, therefore the combination is of utmost value for gland tissue. Most exquisite effects are produced in the cerebellum, bone, and intestine by this method. The sections are generally mounted in dammar, or Canada balsam and benzole. Sections stained in logwood and iodine green, and mounted in dammar, are very good. The acini of the mucous glands are stained a bright green, while the epithelium in the different ducts is of a logwood tint. A high power shows the nuclei stained with logwood.

4.—Eosin and Aniline Blue give good results, but require to be used cautiously, as, if the staining is too deep, the section becomes opaque. The section should be very thin, and must be well washed after staining with eosin, and then just immersed for a few seconds in aniline blue.

5.—Eosin and Logwood are very good for staining the zone of ossification in growing bone. The sections of decalcified bone are first immersed for a few days in a $\frac{1}{2}$ % solution of chromic acid, or 1 % solution of bichromate of potassium, soak the sections in 1 % solution of carbonate of soda for 10—20 minutes, which will be sufficient; wash well. Prepare *two* watch-glasses, containing a dilute solution of logwood, place the sections in one, let them remain for a minute, stir them round, and then place them in the other; stain till deep enough. This prevents a deposit of granules over all the sections; then, after washing well with water, stain in-

a watery solution of eosin, etc. In young bone, where ossification is progressing, the cartilage matrix is blue, while the nuclei of the cartilage-cells adjoining the line of bone are red; the contents of the medullary spaces also are bright red, while in the bone trabecules there is *a combination* of blue and red.

Logwood and Eosin:—

(i.) Make a strong infusion of logwood chips in tepid water, add 3 or 4 drops of this to a watch-glass full of distilled water, and place the sections in it for about 15 minutes.

(ii.) Wash the sections thoroughly in ordinary water, and transfer to acidulated water for a few seconds (30 minims of acetic acid to 1 pint of distilled water), to get rid of superfluous staining; re-wash thoroughly in ordinary water.

(iii.) Place in rectified spirit * for an hour.

(iv.) Transfer to an alcoholic solution of eosin (3 grains to 1 ounce of alcohol) for an hour, or the sections may remain in this solution for any length of time, as the eosin only acts upon the tissue elements to a certain extent, and no further.

(v.) Wash quickly in rectified spirit. If the sections are allowed to remain in the spirit, the eosin stain will be removed, hence it is necessary merely to *rinse* them in spirit, and transfer them quickly to oil of cloves, previous to mounting them in Canada balsam or gum dammar.

6.—Eosin and Aniline colours.—First stain in an alcoholic solution of eosin, then in a 1 % watery solution of an aniline colour (dahlia, methyl-violet, or aniline green). Care must be taken *not to extract* the colour when dehydrating the specimen in alcohol according to the usual method; very deep staining is therefore desirable.

Eosin and Bismarck Brown.—Put the sections in a strong aqueous solution of Bismarck brown, remove after about 2 minutes, set in a weak acetic acid solution (4 %), then place in a weak alcoholic or aqueous solution of eosin, and then again in the acetic acid solution; dehydrate with alcohol, mount in dammar varnish.

* Rectified Spirit of sp. gr. 0·838 should be used here; where, however, it cannot be easily procured, ordinary methylated spirit will do.

7.—Rosein or Aniline Violet.—Immerse in a spirituous solution of rosein or aniline violet, then in an aqueous solution of aniline blue or iodine green.

9.—Borax Carmine and Indigo Carmine.—Two fluids are required, red and blue.

The former is made as follows :—carmine 7½ grains, borax ½ drachm, distilled water 1 ounce. The blue contains indigo carmine ½ drachm, borax ½ drachm, and distilled water 7 ounces. After thorough trituration, the ingredients are mixed and left in a vessel ; the supernatant fluid is then poured off. The sections, if previously hardened in bichromate, picric, or chromic acid, should be well washed ; they are then to be placed for a few minutes in a mixture (equal parts) of the red and blue fluids, then transferred, without washing, to a saturated solution of oxalic acid, and allowed to remain in it rather less time than in the staining fluid. When sufficiently bleached, the sections should be washed in water until every trace of oxalic acid is removed. Sections thus prepared may be mounted in Canada balsam or gum dammar. Connective tissue substances are blue, while the nuclei are red. The osseous lamellæ of bone are blue, the cells in the lacunæ red, while the marrow is apple-green.

10.—Methyl Green and Induline.—The one stains the nuclei of the cells of the sub-cutaneous tissue, the nuclei of the vessels of nerve sheaths rose colour, while the cells of the corium and their nuclei are a violet red ; the other colours the cells of the Malpighian layer a greenish blue.

Methyl Green and Eosin are also very good. Eosin 1 part and methyl green 60 parts are to be dissolved in a 30 % solution of *warm* alcohol. The epithelial nuclei take a violet blue, the nuclei of connective tissue a greenish blue, and the cell-body a red colour.

Note the singular differentiations :—Thus, while the striated muscle is red, the nuclei are green. On the other hand, smooth muscular tissue is green, the intercellular substance red. In the salivary glands the cells of the excretory ducts are stained blue, while the so-called secretory cells are red. Induline dissolves in warm water and in dilute alcohol. Take a concentrated watery

solution, dilute it with 6 times its volume of water, then immerse the preparations from 5 to 20 minutes, wash them out and clarify in oil of cloves, or glycerine. The peculiarity of this material is that it never affects the nucleus, but only the cell-body. More frequently, however, it is the intercellular substance that is coloured blue.

Sulphindigotate of Soda and Carmine.—Stain as usual in carmine, wash in rectified or methylated spirit, remove the sections from the spirit into 5 parts methylated spirit, and add to it 1 part of pure hydrochloric acid for about 10 minutes. Wash in strong rectified or methylated spirit, and allow the sections to remain in it for an hour or two, so that all trace of the acid may be removed. Transfer the sections into a large quantity (from 2 to 3 ounces) of the following for from 6—8 hours:—Add 2 or 3 drops of a saturated solution of sulphindigotate of soda to 1 ounce of methylated spirit. This solution should be made as required, from time to time. Mount in Canada balsam or dammar (Cole, vol. i.).

Ribesin and Eosin.—For the method of making the first stain see the additional recipes in our next. A double stain may be at once obtained by adding a little eosin to the above ribesin solution, and filtering. (The filtrate should be cherry red.) Wash the sections with absolute alcohol, charged with a little eosin, and clear with clove oil also charged with eosin. The blue of the ribesin remains fixed in the nuclei. In many respects this is a better double stain than Renaut's Hæmatoxylin eosin.

Treble-Staining.—Gibbes recommends (1) picro-carmine, (2) rosein, and (3) iodine green. Stain the sections well in number 1, and soak them in acidulated water. Immerse the sections for 2—3 minutes in a few drops of a solution of rosanilin hydrochlorate diluted with spirit, then remove to methylated spirit, and wash off the excess of the colouring matter. Place in a dilute solution of iodine green. Coming from spirit the sections will *float* on the top of the watery solution, and this in many cases, when the green stain is not required very deep, is sufficient. If a deep stain is required immerse them altogether, and let them remain a minute

or two; bear in mind that this colour *cannot* be washed out again if too deep. Although the spirituous stain may do, it is better to have a section apparently *overstained* in the rosanilin solution, while it is even *under-stained* in the iodine green. After washing, mount the sections in the usual way. (A good deal of the rosanilin will come out in the second immersion in spirit, which it is necessary *to change* until no more colour comes away; otherwise the oil of cloves and Canada balsam will be coloured, and the specimen spoilt). The results vary with the length of time the section is immersed in each of the two last colours, and also the strength of the solutions. If the sections are to be laid aside before mounting they should be kept in oil of cloves. The best results are obtained from material soaked in chromic acid, when only a few are stained at once. The staining process is well shown in a section of the base of a cat's or dog's tongue, cut through one of the circumvallate papillæ, including some of the mucous glands. Muscle fibres, connective tissue, protoplasm of cells, etc., stained with picro-carmine, are red; all nuclei in the superficial epithelium, serous glands, non-striped muscle tissue, in vessels, etc., are green. Take only a few sections at a time and do not hurry over the different processes, after a few trials the exact time of immersion will be learnt, and *should be recorded.* Always keep a note-book handy, and enter any little items which are likely to prove useful in future work.

Staining with four, five, and six different pigments. (1) Picro-carmine or eosin, (2) logwood, (3) aniline rose, (4) aniline green, and (5) iodine. If the tissue has been already stained in gold chloride or nitrate of silver, which also gives good results, six stains will have been used. I have seen specimens so stained, such as sections of Tongue with taste organs, salivary gland, ovary, and testis; in each case the different parts came out with remarkable distinctness.

11.—Gold Chloride and Anilines.—Striking results may be obtained by first staining fresh tissues, especially growing bone, in a chloride of gold solution, then decalcify and harden in spirit. When hardened sufficiently, sections may be cut and stained with two colours. What action chloride of gold has on those parts,

which it does not stain is not known, but that it has some, is evident, from the difference of the action of aniline dyes to those specimens prepared with gold. For example, take the tail of a young rat or mouse, place in ½ % solution of gold chloride for an hour or two, then decalcify and harden as usual. Very thin sections should be cut and stained, first in rosanilin and then in iodine green. It will be found that the periphery shows gold staining, bringing out the tendon cells and giving a dark hue to everything for a certain distance from the outside; but within, a great variety of colour will be found. In the middle the bone trabeculæ will be seen faintly stained, the calcified cartilage in their centre is stained a bright colour, totally different from the rest. All these colours may be varied by using different aniline colours; a pretty result may be obtained by simply staining with iodine or methyl green.

Half-an-Hour at the Microscope
With Mr. Tuffen West, F.L.S., F.R.M.S., etc.

Seeds of Campanula carpatica (Pl. V., Fig. 1).—Seeds have been much less frequent visitants in our travelling boxes than they deserve to be, both on account of their beauty and interest. Would the exhibitor of the present slide enlighten us as to the cause of the iridescence here shown? It would be necessary to make transverse sections, and then to separate each coat of the testa, mounting each in glycerine jelly. It will probably be found that the external walls of the cells forming the outer seed-coat are exceedingly thin, and in consequence polarise the light passed through them; a similar property being possessed by superimposed plates of glass, as is familiarly known to soirée attenders. In some cases the membrane named is so thin that it is difficult to believe it present when the seed is viewed as an opaque object; this may be well seen in the seed of the Whortle-berry (*Vaccinium myrtillus*). In the seeds of a very extensive natural order, the *Solanaceæ*, the outer membrane becomes entirely absorbed during the process of ripening, whence arise appearances very difficult of explanation, without watching the changes during development.

A paper on this subject was laid before the International Botanical Congress of South Kensington in 1866, and will be found in the published report of their proceedings.

Polycystina from West-Indian Soundings (Pl. V., Fig. 2).—This slide contains a large number of forms; and for its correct appreciation it requires to be gone over carefully, *seriatim;* examining every specimen with Maltwood's finder, taking the place of each, drawing and taking notes on everything present. Even fragments must be treated with the same care, for they often throw a light on structure which examination of perfect forms fails to reveal; they are, in fact, dissections made ready to hand. The slide will then be found to be truly a *multum in parvo.* To stimulate, not satisfy, inquiry, a few have been sketched. Access should, if possible, be obtained to Ehrenberg's original papers on the subject, published in the Transactions of the Berlin Academy; a few forms are figured in "Carpenter on the Microscope," pp. 520—22 (ed. 1856); also in the Micrographic Dictionary, "Opaque Polarising Objects." Some figures executed on a large scale by a lady were to be seen at various places in London a few years ago. Thus, in the Proceedings of the Linnæan Society (1866—7) are some valuable papers on "Living Polycystina," by Major S. R. J. Owen; an abstract of these will be found in "Hogg on the Microscope" (1867). Dr. Wallich also has had some important papers on the subject, and there have been various notices of these interesting forms in the accounts of the *Challenger* expedition. It would be desirable to state when they were obtained, by what vessel, the depth whence procured, and any other particulars of value.

Foraminifera from March, Cambridgeshire (Pl. V., Fig. 3).—In this instance again it would have been desirable to give particulars whence the specimen shown was obtained, and when; the character of the bed, etc. Though there are many forms here, the number of species is not great. A few of the most marked types have been sketched to stimulate examination and inquiry. The slide will be found to present much of interest on proper study. The work to read in connection with it is Williamson's "Foraminifera," Ray Society, Monograph, 1857; Carpenter's "Introduction to the Study of the Foraminifera," Ray Society, vol. for 1862, may also be read with advantage. These two will probably satisfy most of our members' appetites for the present; to those who have strong digestion, it may just be remarked in passing that the literature of the subject is a vast one. I believe it correct to state that the beautiful glass bottles classed under various specific names in the genus *Lagena* are most abundant in

a semi-fossil deposit found in the fens of Lincolnshire, much like that whence the present specimens were obtained. There are here also some valves of Entomostraca. To learn these it would be requisite to study the monograph on this subject, recently published by the Palæontological Society, of which Geo. S. Brady and another are the authors.

Head and Leg of Aphrophora spumaria (Pl. V., Figs. 3—10).—*Aphrophora* belongs to the *Cirpopidæ*, and is a good and readily-procured example of that family, one of the generic characters of which consists in the presence of ocelli on the crown of the head; these, of course, from their position, we cannot see in the example before us. The antennæ are three-jointed; inserted *between*, not beneath, the eyes; the last joint looks just like a very fine bristle. The face has a large, swollen, transversely striated piece. The mouth is of that type to which the term "promuscis" is applied; the lower lip turns upwards at the sides, forming a sheath to the remaining organs. The determination of the true nature of these is not easy, so greatly are they modified; but I should judge that the two outer, which form a pair, are maxillæ; the two inner, so closely united that they appear to form but one, and apparently superposed, would in that case be labrum and lingua. We must dissect this in the coming season, and see how far such determination is correct. Labial and maxillary palpi are both absent. The dentation of the posterior tibiæ forms a valuable character for the determination of species. Here two strong spurs are present, with a group of the like at the end of this limb and of the two first tarsal joints. The tactile hair proceeding from the base of each spur is a noteworthy feature; its object being to convey impressions to the brain of the nature of the object on which the creature may be at the time, or amongst which it may be moving. In specimens taken shortly before exuviation, the two skins may be well seen, the one within the other; such form very interesting objects. I have never seen exuviæ *in* the frothy matter, but must look out for them. See Dr. Moore's note, p. 50.

Antenna of Oak-Eggar Moth, Lasiocampa Quercus (Pl. VI., Fig. 11).—The Oak-Eggar belongs to the *Bombycidæ*. A systematic display of the antennæ from male and female moths in this family would be highly interesting and valuable. The power possessed by the males of finding their mates is most remarkable. Old entomologists tell curious stories of this kind. One narrates to me how that, carrying some female Bombycides by train between Liverpool and Manchester, several males of the species dashed against the windows of the carriage in which he was

travelling with them in a closed box. How could these gentlemen become aware of the presence of their partners? By hearing, by smell, or by some power unknown to us. Westwood, too, narrates facts of a similar kind, and refers to others (Intro., M.C.I., II., 384). The antennæ of Silkworm Moth, ♂, is another interesting example of corresponding formation in the antennæ.

Tail of Larva of Puss-Moth, Cerura vinula (Pl. VI., Fig. 10).—After E. Lovett's graphic description of the habits of this creature (see page 49), little need be said further on it; but we should much like to see the whole tail, whip-lash, butt, and all. It would not be difficult when rearing the larvæ to induce one to put them out; then snip off close with a pair of sharp scissors kept ready to hand for the purpose; then mount (probably, with *gentle* pressure). I remember an example in the cabinet of a friend; in this case, the larva was just hatched, and is preserved entire (see Pl. VIII., Fig. 5). I see no reason to think there can be any poisonous secretion; for the scale-armour of the *Ichneumon*, against which they are used (which, on the anthority of Westwood, is *Ophion luteum*), would suffice to shield it from such injury. It appears that these whip-like organs are *the last pair of pro-legs specially modified!*

Lepidopterous Larva found about Cheese (Pl. VI., Figs. 1–9).—Here indeed we have a puzzle presented to us, which, I fear, will take a long time to unravel. Did you ever hear of a caterpillar eating cheese? I never did. And, what is more, I couldn't have believed it, but that here we have the Epicurean barbarian made to tell what he has been up to, as surely as any whining beggar, when police action reveals the contents of his wallet, to find therein all sorts of goodies, with money, banking books, and even a post-office order for £10! to pay a fine imposed by the magistrates with costs—"If anything over, the balance to be returned to the sender!" I am quoting here a literal case which occurred recently in this neighbourhood (Fareham, Hants) that I was reading about only yesterday. The only thing that can now be done with the present fellow is to take his portrait as accurately as possible, and by-and-bye some of the "detectives" in our Society will find out who and what he is. 'Tis certainly a most singular case! The claws of the pro-legs very curiously resemble the strings of grizzly bear claws worn by Red Indian warriors in proof of their prowess!

Larva of Beetle (Pl. VII., Figs. 1—4).—I wish I could communicate the pleasure felt in having, after giving it a "world of

thought," attained a clear conclusion as to the specimens now before us, and being enabled to say that it is a "Wireworm," the larva of one of the larger "Click-Beetles" (see Fig. 5, Pl. VII.). Jumpers we used to call them when I was at school. We put them on our hands, back downwards, and with a sharp click and a spring they would fall on their legs, and then proceed to run away—a provision, we are informed, for enabling them to recover their balance when they fall in a wrong position (which they are very much given to, feigning death on the slightest disturbance).

It would not be difficult to surmise how the three earth-lovers came into the sewer (see p. 52); they evidently lived well there. The mode of their removal to daylight is truly a very curious part of the story. The termination of the last segment furnishes a character whereby the actual species may be determined.

Haltica fuscipes (Pl. VIII., Fig. 1).—Many thanks to J. Carpenter (p. 50) for illustrating his subject so carefully. This is the right way to do. Every member, on enclosing his slide, should submit a drawing of it, with careful notes, the best in his power to obtain. The main difference, by-the-bye, between our Society and those longer established, and meeting at stated times in definite localities, will be that, owing to the variety of mind, acquirements, and occupations in our body, we shall learn much faster; have vastly greater opportunities of acquiring specimens and information of all kinds.

It needs for me here to say little. But as J. C. has not marked the mouth-organs I will indicate them in an appended outline (Pl. VII., Fig. 8), for we shall have to make ourselves thoroughly familiar with them in all their modifications.

I have further added a sketch of the hind tibia of *H. concinna* for contrast with the present example of the genus *Haltica*, in which it will be seen that these peculiar spikes are entirely absent. The most remarkable part about *Haltica concinna* to myself is the structure of the legs, the enormously incrassated posterior thighs for leaping, the dilated tarsal joints, the penultimate having numerous curved hairs, serially arranged, and expanded at their extremities to form suckers, after the manner of those in the common fly, etc. It is curious to watch the mode of progression in ordinary walking of these beetles, which may be readily seen in the live-box. The feet of the posterior pair are brought forwards, so as to be right under the centre of the body; the advantage of this in connection with the powerful spring may be readily conceived. The curious array of spines terminating the tibiæ I take to be principally for enabling a firm grasp to be obtained on alighting after the leap on the polished stems, leaves, etc., it

mostly lives on. Just for the same reason as the mountain-climber on ice gets a pair of boots with strong, sharp spikes in their soles to enable him to retain a firm footing on the treacherous surface he moves on.

Animal of Barnacle (Pl. VII., Fig. 6).—By the kindness of Charles Darwin, I have been enabled to consult original specimens and figures prepared for his (Ray Society) work on the Cirripedia. The history of the creature reads like a romance. When first hatched, it is a free swimmer, in shape like a kite with six legs, the two hinder pairs forked (Fig. 7., Pl. VII.). After successive moults, it settles on its head, the antennæ lay hold of what the creature considers a suitable object for adherence to, cement-glands at their base pour out a secretion, and thenceforth what is known as "retrograde metamorphosis" takes place. The head becomes, so to say, lost, as well as the abdomen; the part that is left is thoracic; the shell, the thoracic shield. Of the five pairs of limbs left, the first appears to assume the functions of the lost antennæ. "Each of the cirrhi is composed of a series of semi-corneous pieces, exhibiting at each joint long, stiff hairs. Every pair of cirrhi arises from a single prominent stem, and those most distant from the mouth being the longest and most ostensible, the whole apparatus, consisting of twenty-four" (twenty here, I think; another species is under description), forms, when protruded from the body, a kind of net of exquisite contrivance, in which passing particles of nourishment are easily entangled, and thus conveyed to the mouth. The latter is seated on a prominent tubercle, and is composed of three pairs of mandibles, the two outer horny and serrated, and of a lip with rudimentary palpi. The digested food passes out through an orifice behind and at the base of the last pair of cirrhi. Arising from this part is seen a long, flexible organ, the nature of which has much puzzled investigators; it has been taken for a *tail*, a *penis*, an *ovipositor*. The latter supposition appears to have most to support it. There are good grounds for believing that an eye is present. "Mr. Darwin observes, vision seems to be confined to the perception of the shadow of an object passing between them and the light; they instantly perceive a hand passed quickly at a distance of several feet, between a candle and the vessel in which they may be placed." There is also an organ of hearing of a simple kind. Our limits will not permit of more extended remarks here. A good summary will be found in Rymer Jones' "Outlines of the Animal Kingdom," pp. 449—463, ed. 1861.

TUFFEN WEST.

Selected Notes from the Society's Note-Books.

Tail of Larva of Puss-Moth, Cerura vinula (Pl. VI., Fig. 10).—The tails, two in number, are more fully developed in the young larva than in the adult, where they appear to decay or shrivel up from the end downwards, so that by the time the larva is ready to assume the pupal form, I have known the tail to have *entirely* disappeared. In the young larva they are long and black, and when the insect is alarmed it assumes a most comical position, throwing up the end of its body and raising its head, only holding on by the middle feet (see Pl. VIII., Fig. 3); and, what is most remarkable, the tail throws out a long, thread-like membrane, which is withdrawn after the cause of alarm has disappeared. Two questions occur to me:—Are these appendages used by the young larva as a means of defence from the attacks of the Ichneumons, which have an especial liking for depositing their eggs in the body of the larva of *C. vinula?* and, Are the red threads poisonous, or merely used as a whip to keep off the enemy? I fancy, if fellow-members or readers would record their ideas and observations on the subject, it would meet with much approval.

It is curious to observe the various ways by which larvæ show their fear or disapproval of being disturbed. The larvæ of the Sphinges throw back their head and fore-part of the body, waving it to and fro as if very angry at being interrupted at their meals; whilst most of the hairy larvæ—such as *Arctia caja* and others—roll themselves up in a ball and drop, not caring where, for their long hair prevents their receiving any injury; but if by chance they fall into water, as they sometimes do, they very quickly unroll themselves and struggle to get out. Then, again, the Loopers, or larvæ of the *Geometridæ*, often assume a position exactly resembling a branch or a twig, holding on only by the anal claspers, as in Fig. 4, Pl. VIII.; and so closely do they resemble the twig that an experienced collector will often overlook rare and valuable larvæ when they are just under his very eyes.* This strong resemblance between insects and their food-plants is also most strikingly shown in many tropical insects, as all naturalists are aware, and is a grand provision of Providence for their protection.

E. Lovett.

* We once plucked a small branch of the wild rose, and had carried it in our hands for half-an-hour, before discovering that a full-grown "Looper" was attached to it.—Ed.]

American Potato-Beetle, Doryphora decem-punctata (Pl. VIII., Fig. 2).—Shall be glad to learn the ideas of our readers as to the probability of this beetle becoming naturalised in Britain. How is it that we have not heard of it before? By the side of my drawing will be seen a cross, giving the dimensions of the beetle when living; when dead, the head and thorax are bent down unless properly set, so that a badly set dead specimen does not look quite so long as a living one.

EDWARD LOVETT.

Aphrophora spumaria, Cuckoo-Spit (Pl. V., Figs. 4-10).—The *Aphrophora* is an Hemipterous insect, included in the sub-order Homoptera; it is the common Cuckoo-Spit, or Frog-Hopper. The larval, pupal, and perfect states are all alike except as to size and the presence of wings, which are only found in the imago. Casts of the larva and pupa, may always be procured in abundance by removing the frothy secretion so commonly seen in our gardens, and are interesting as showing the completeness and neatness with which the change of skin is made.

DANIEL MOORE.

Foraminifera to Mount in Balsam.—The plan I adopt to get rid of the air in Foraminifera is to boil them in dilute potash for a few moments, afterwards in pure water, and then thoroughly dry them. Now, put them into a test-tube with spirit of turpentine, and boil for a few minutes over a spirit-lamp. When wanted for mounting, place a drop of balsam on a slip, take up a small quantity of the shells on the point of a penknife or a homœopathic spoon, and immediately place in the balsam; then put on the cover-glass, but do not use any pressure. They require baking in a slow oven for some time to thoroughly harden the balsam.

JOHN CARPENTER.

Haltica fuscipes (Pl. VIII., Fig. 1) is a small beetle, resembling the farmer's pest, the "Turnip Flea," so called on account of its habits. In September (1875) I found a quantity of *H. fuscipes* on the leaves and flowers of some hollyhock plants here, whose appearance was completely spoiled, the leaves being riddled with small holes, the work, I presume, of these beetles whose jaws seem well adapted for the destructive work. I have not yet succeeded in finding the larvæ, but probably they are hatched from eggs laid on the under-side of the leaves, the young caterpillars

living between the cuticles in the same manner as the larva of the Turnip-Beetle, *H. nemorum*.

The drawing is from the slide now sent, but of course it gives no idea of the colour of the living insect; the wings also are not shown. When living, the beetle is black underneath, and of a dark metallic green colour above. On attempting to catch them, they make a spring and drop on to the ground, folding their legs under the body, apparently feigning death.

JOHN CARPENTER.

Notes on Haltica.—*Haltica fuscipes*, *Haltica nemorum*, and *Haltica concinna*. In modern nomenclature there is no such thing as either of these insects. The first is *Podagrica fuscipes*, the second *Phyllotreta nemorum*, and the third *Plectroscelis concinna*, all belonging to the sub-family *Halticidæ*. Some of the distinguishing characteristics are as follows:—The genus *Plectroscelis* has the posterior tibiæ toothed in the middle of the outer side. The genera *Haltica*, *Podagrica*, and *Phyllotreta*, have no tooth on the outer side of the tibiæ. In the genus *Haltica* there is a transverse furrow at the base of the thorax. The genera *Podagrica* and *Phyllotreta* have no furrow at the base of the thorax. In the genus *Podagrica* the clyta have punctured striæ; and in the genus *Phyllotreta* the elytra is either confusedly punctured or smooth. There are other characteristics, but the above suffices to at once separate the four genera mentioned.

ROBERT GILLO.

Ichneumon Flies from Chrysalis of Butterfly.—In August, 1872, I obtained a chrysalis of the *Atalanta* butterfly, which had the appearance of burnished gold. I placed it in a glass-top box, and waited for the development of the butterfly, instead of which I observed two small holes in the case, and issuing therefrom in quick succession was a number of beautifully-coloured Ichneumon flies in a perfectly developed form. Being somewhat surprised at this and at the number, which amounted to 157, I carefully opened the deserted chrysalis, and there found an equal number of cast skins, which had just been thrown off previous to their emerging from the case. How so great a number could exist and go through their metamorphoses in so small a space to me appears marvellous.

JAMES FULLAGAR.

Larva of Beetle (see Mr. West's note on p. 46).—An old sewer-rat used to pay his visits every dinner time; he was caught at last, and killed by drowning. I was surprised, on taking him out of the pail, to see three large horny larvæ escape from his fur. In life they resembled meal-worms, slightly darker and more active. Shall be glad if some friend will name them.

B. WADE.

Barnacle.—T. R. Jones, in "The Animal Kingdom," p. 236, states that the Barnacle, when young, has *six* "*pairs*" of swimming legs that act in concert, like oars. There is a very good description of the Cirripedia in this book, which will be interesting if read as a sequel to Mr. Tuffen West's valuable notes.

E. E. JARRETT.

Tail of Larva of Puss-Moth.—I have a slide showing the red thread exserted, but I cannot make anything of its structure or use. There is a short, stiff bristle at each spur, which is worthy of notice.

H. E. FREEMAN.

Living Insects.—I am endeavouring to make myself acquainted with the appearance and habits of *living* insects in their native beauty, on the wing, feeding, and at rest. It appears to me that far too much time is devoted to mounting and examining slides, and very little to studying insects alive. It is generally much easier to identify mounted insects from living, or at any rate unflattened insects, than to identify living specimens from the flat preparations of the opticians. These beautiful preparations have their uses, and I am a strong advocate for "whole mounts," but I hope all our members will not be content without seeing, as far as possible, living specimens. I believe many so-called *uncommon* insects are merely so because people fail to recognise them, or that they seek them in wrong places. Further, it is desirable to confine one's attention—say, for each season—to, at most, one order, or, better still, one genus of insects.

H. E. FREEMAN.

EXPLANATION OF PLATES V., VI., VII., VIII.

PLATE V.

Fig. 1.—Seed of *Campanula carpatica*, × 50 diam., viewed as an opaque object.

,, 2.—Polycystina from West Indian soundings :—
a, *Podocyrtis Schombargkii.*
b, *Encyrtidium elegans.*
c,
d, *Astromma Aristotelis.*
f, *Lychnocanium lucerna.*
g, *Lychnocanium falciferum.*
i, *Lithocyclia ocellus.*
k,
l, *Haliomina Humboldtii.*
m, *Anthrocyrtis*, ? sp. All × 100 diam.

,, 3.—Foraminifera from March, Cambridgeshire.
a, *Rotalina inflata*, with contained animal.
b, *Textularia variabilis typica.*
c, *Truncatulina lobata.*
d, *Rotalina concamerata jun.*
e, *Rotalina* or *Truncatulina.* Edge view.
f, *Nonionina umbilicatula.*
g, *Miliolina seminulum typica.*
h, Shell of Entomostracan. All × 50 diam.

,, 4.—Head of *Aphrophora spumaria*, seen from the front :—*at. at.*, antennæ ; *oc. oc.*, mark the position of the ocelli ; at the lower part is seen the *promuscis*, to view the internal setæ of which the greater part of the lower lip has been removed ; *mx. mx.*, maxillæ ; *lbr.* and *lg.*, labrum (upper lip) and lingua (tongue), × 15 diam.

,, 5.—Ends of maxillæ more enlarged, × 100 diam.

,, 6.—Outline (side view) from another specimen, showing under-lip, *lb.*, which forms a sheath to the inner organs.

,, 7.—Side view of the same.

,, 8.—Hind leg ; the under surface shown, *cx.*, coxa; *tr.*, trochanter; *f.*, femur ; *tb.*, tibia ; *trs.*, tarsus, × 15 diam.

,, 9.—Lower dentation of the (posterior) tibia.

,, 10.—Spurs terminating the tibia, with tactile hairs arising from the base of each.

Drawn by Tuffen West.

PLATE VI.

Fig. 1.—Caterpillar found about cheese, × 7 diam. The segments are numbered consecutively. *p.l.* 1, 2, 3, 4, 5, signify first, second, etc., pairs of prolegs.

,, 2.—Head more enlarged, × 15 diam. ; *e.e.*, eyes, consisting of (apparently) only two ocelli each ; six is a usual number.

Fig. 3.—Trophi, × 25 diam. *ant.*, antenna; *md.*, mandible; *lbr.*, labrum; *mx.*, maxilla; *lb.*, labium; *lb.p.*, labial palp.

,, 4.—Proleg of the second pair, × 50 diam.

,, 5.—Proleg of the fifth (terminal) pair, × 50 diam.

,, 6.—Spiracle, and one of its vibrissæ, × 100 diam.

,, 7.—Albumino-oleaginous pellets, *i.e.*, Cheese, × 50 diam.

,, 8.—Cheese-Mite in the intestine, × 50 diam.

,, 9.—Ovum of Cheese-Mite from ditto, × 50 diam.

,, 10.—Tail of Larva of Puss-Moth.

,, 11.—Antenna of Male Oak-Egger Moth.

Drawn by Tuffen West.

Plate VII.

Fig. 1.—Larva of Coleopteron (Click Beetle), × 4 diam. 1—13 indicate the segments composing it, 1 being the head; 2, 3, 4, the thorax (pro-, meso-, and meta-); 5—13, the abdominal segments; *sp. sp.*, spiracles; *pss.*, prosternum; *plg.*, position of the large fleshy retractile tubercle ("proleg") employed as a seventh leg in progression.

,, 2.—Head, × 10 diam. *ant.*, *ant.*, antennæ; *md.*, mandible; *mx.*, maxilla; *mxp.*, maxillary palp; *lbr.*, labrum; *lb.*, labium; the labial palpi not seen, their position is just at the outer angles of the labium; *o.o.*, minute eyes.

,, 3.—Feet of the third pair, × 10 diam., armed with strong, short spines, and terminated each by a sharp claw.

,, 4.—Terminal segment, × 10 diam.

,, 5.—Outline sketch of Click-Beetle (Imago of Wire-Worm).

,, 6.—Animal of Barnacle or Acorn-shell, *Balanus tintinnabulum*, × 10 diam.
1 1, The first pair of cirrhi.
2 2, The second ditto, and so on.
m., the mouth; *st.*, stomach.
op., *op.*, *op.*, *op.*, ovipositor.

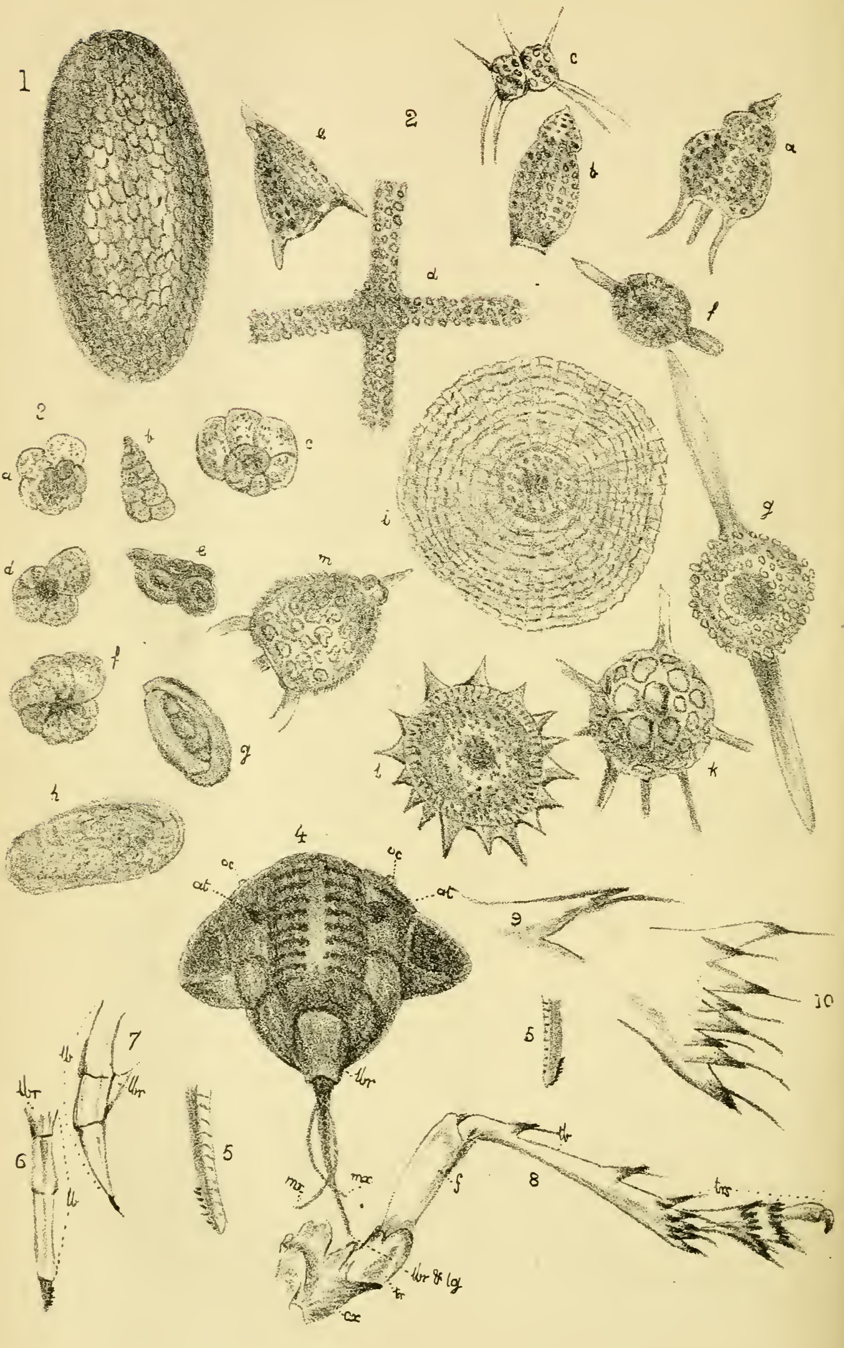
,, 7.—Newly hatched Barnacle.

,, 8.—Outlines of part of Mouth of *Haltica fuscipes* (see also Fig. 1, Plate VIII.). *md.*, mandible; *mx.*, maxilla; the inner lobe is furnished with a brush of short, stout hairs. The outer lobe is barrel-shaped, and has some organs of taste appended to it; it is marked by *mx*, *2 l. mxp.*, maxillary palpus; *lbr.*, labrum (upper lip), through this is seen *lb.*, the labium, with its *lb.p.*, labial palpi; *mt.*, mentum, on which the labium is hinged at antenna.

,, 9.—Left hind leg from above, for comparison with—

,, 10.—End of tibia from *Haltica concinna*, to show the strong, sharp spikes terminating it; this appears to me to indicate a pre-eminently saltatorial species.

Drawn by Tuffen West.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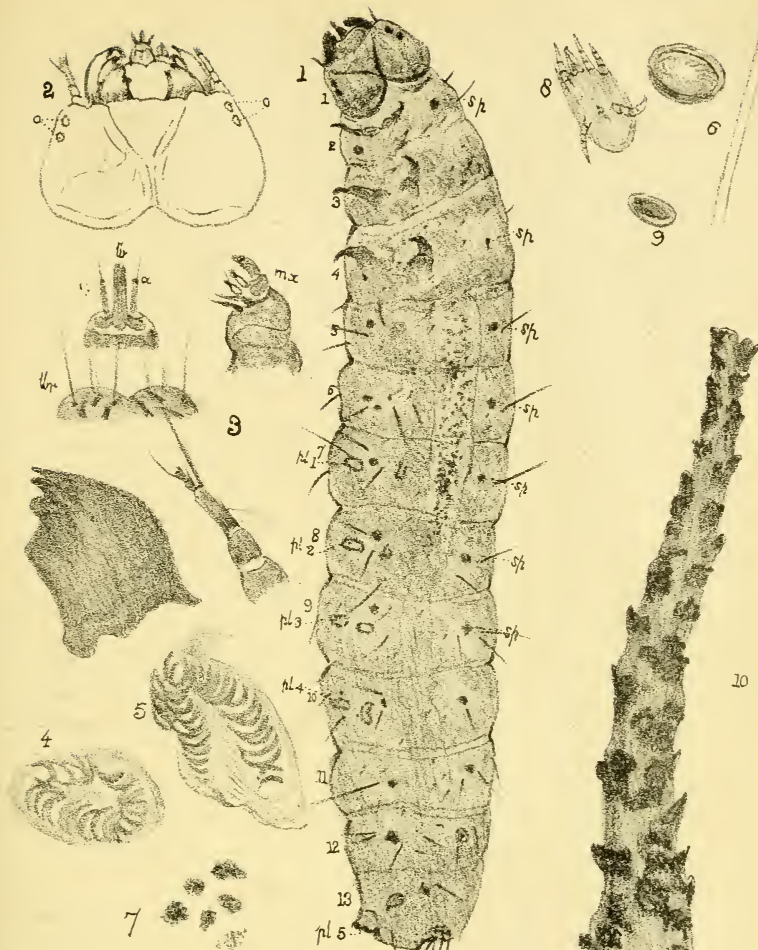
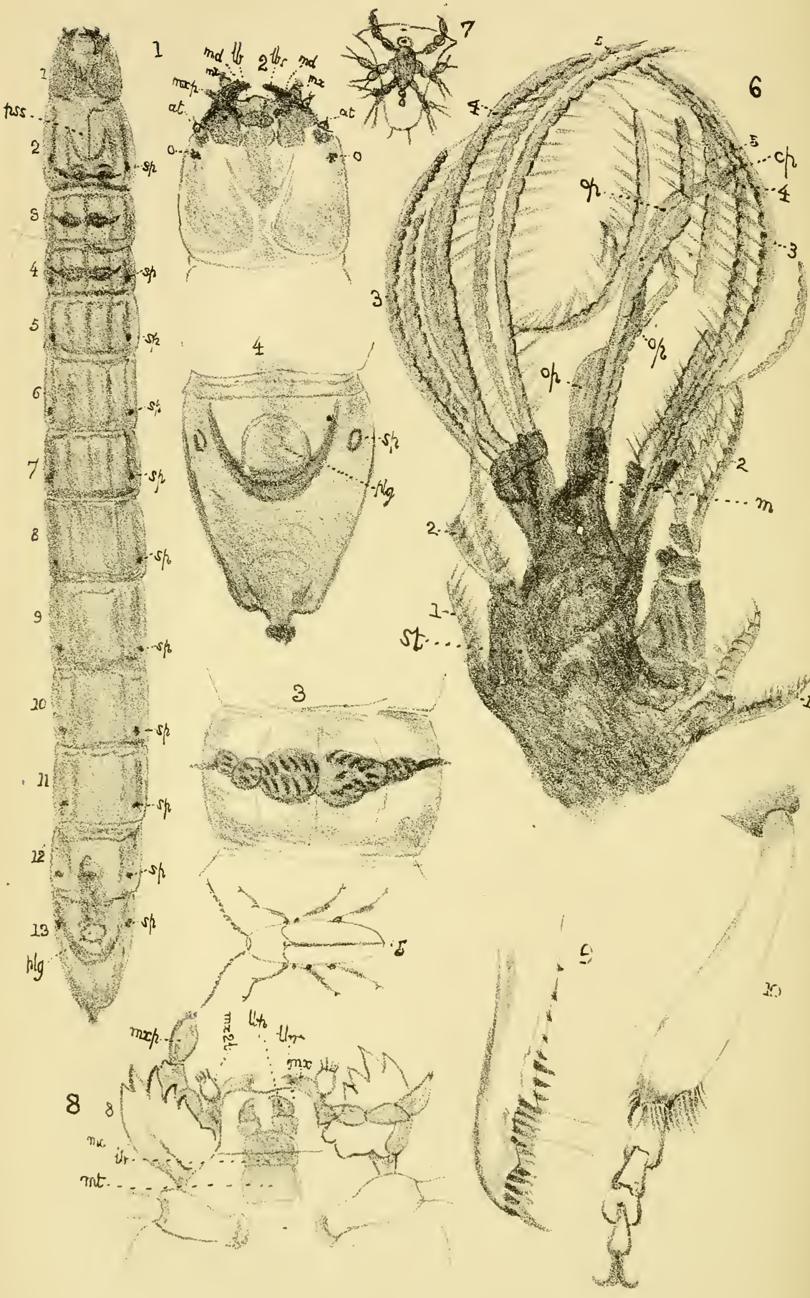


Tail of Larva of Puss Moth.

Caterpillar found about Cheese.

Antenna of Male Oak-Eggar Moth.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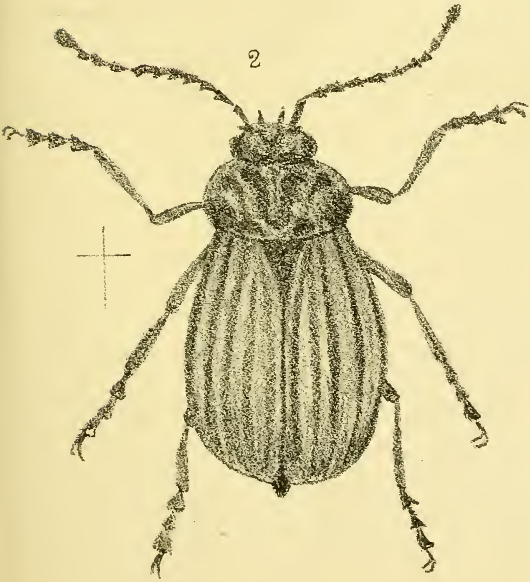
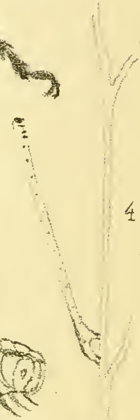
Haltica fuscipes (from a slide.)





Doryphora decem-punctata.

PLATE VIII.

Fig. 1.—Hollyhock Beetle, *Haltica fuscipes*, × 15.
Drawn by J. C. Carpenter.
,, 2.—American Potato-Beetle, *Doryphora decem-punctata.*
,, 3.—Larva of Puss-Moth.
,, 4.—Larva of one of the *Geometridæ.*
Drawn by E. Lovett.
,, 5.—Young Larva of Puss-Moth, from a mounted slide.
Drawn by Tuffen West.

Correspondence.

The Editors do not hold themselves responsible for the opinions or statements of their Correspondents.

To the Editor of the Journal of Microscopy and Natural Science.

"POND LIFE."

SIR,—

Mr. Hoyle, in his paper on "Pond Life," in the October number of this Journal, gives, in four pages, a brief account of the Infusoria, which contains so many mis-statements, some of them of a very important nature, that it seems worth while correcting them. I will take them in the order in which they occur.

1.—It is stated on p. 248 (Vol. IV. of this Journal), that it is an open question whether the eye-like pigment spot of the *Euglenæ* is really an eye or not. Accurate observations are said to be needed, and to be difficult on account of the activity of the animal.

Naturalists, generally, have given up the idea that these spots are eyes. They are considered to be oily or pigment corpuscles, resembling the isolated coloured corpuscles possessed by many unicellular plants. It is easy to reduce the activity of *Euglenæ* to any extent required. Engelmann's recent researches show that while *Euglena*, like some other Infusoria, is sensitive to light and darkness, and is differently affected by the different rays of the spectrum, this result is not due to the eye-spot, for the motion begins before the shadow reaches the eye-spot.

2.—"They illustrate one group of the Infusoria, characterised by having one long hair-like process, whence they are known as Flagellata."

This seems to assert that all the Flagellata have one flagellum. A great many of the Flagellata have two, three, or more flagella.

3.—On page 250 it is stated that when Vorticella divides by longitudinal fission, one of the zooids swims away by means of the cilia, which, when the animal is fixed, make a whirlpool to catch its food.

I do not believe that there is any authority for this statement. As far as my own experience and reading goes, the zooid which becomes free develops a supplementary ring of cilia towards the base of the body, and it swims away, so to speak, tail-foremost. When it has found a convenient place for settling down, it fixes itself by this temporarily foremost end, and proceeds to grow a stalk; the supplementary row of cilia is absorbed, and the cilia round the mouth developed.

4.—On the same page, encysted Vorticellæ are said to give birth to sucker-bearing animalcules, which subsequently become Vorticellæ.

This is the celebrated Acineta theory of Stein, which was started by that distinguished naturalist in 1849, and fully developed by him in his work published in 1854. But Claparède and Lachmann conclusively showed, in their works published between 1855 and 1860, that these supposed young are really parasites belonging to a totally different and higher group of the Protozoa. Stein himself has abandoned the theory in his later works, and it will not be found in any recent text-book. Now-a-days no one holds this theory, or has done for the last 20 years.

5.—On p. 251, in the description of *Paramæcium*, it is stated that the function of the contractile vacuoles is to force out the fluid contained in them, and to carry it along tubes all through the body. This process is said to be analogous to the circulation of the higher animals, the vacuole is called a heart, and the radiating tubes blood-vessels.

The tendency of all recent investigations has been to show that the radiating tubes act simply as drain-pipes, to collect the liquid from the general mass of the protoplasm, and convey it to the contractile vesicle, which, in contracting, expels it from the body. Fine openings have been seen on the exterior leading to the vesicle. In *Paramæcium*, when the vesicle contracts, the rosette-like tubes remain filled, and this fluid seems to fill the vesicle when it next expands. If this view is correct, and it is the generally accepted one, there is no real resemblance to a heart. Mr. Hoyle says his readers are not likely to see these rosette tubes; this is true if the animals are freely swimming about in a healthy condition, but confinement and pressure in a live box, or compressorium, produce them pretty easily.

6.—Mr. Hoyle says that *Paramœcium* reproduces itself by dividing down the middle.

This was believed to be the case till 1858, when Balliani showed that it was an error. Reproductive fission in *Paramœcium* is always transverse, across, not down the middle. What had previously been taken to be cases of reproductive, longitudinal fission, were then shown to be only cases of temporary conjugation, which may last for several days.

7.—In the account given of conjugation, the nucleolus of one individual is said to combine with the nucleus of the other, and *vice versâ*.

According to this theory, the nucleus and nucleolus function as ovary and testes respectively, or true male and female elements. This was asserted by Balbiani in 1878, and subsequently supported by other observers. But the recent researches of Engelmann and Bütschli have rendered this theory more than doubtful. According to these authors, as epitomised by Mr. Saville Kent, the nucleus of each of the conjugating individuals is entirely absorbed in the general body-sarcode, and by-and-by an entirely new nucleus is formed by the assemblage of fragmentary particles derived from the same body-sarcode. The old nuclei in *Stylonychia mytilus* are broken into four fragments, and ejected from the body. Bütschli holds that there is no essential difference between the nucleus and nucleolus, the latter sometimes even developing into the former.

8.—After conjugation, *Paramœcium* is stated to give birth to little bodies, which develop into sucker-bearing *Acinetæ*, which remain sticking to their parents and sucking their juices for a while. These then develop into the parent form.

This is Stein's old theory again, of 1854, since abandoned by him and every one else. Mr. Hoyle's paper represents the state of our knowledge about 25 to 30 years ago; but much knowledge has been gained since then with respect to these interesting little creatures.

J. G. GRENFELL.

To the Editor of the Journal of Microscopy and Natural Science.

SIR,—

I make no pretensions to being a specialist as regards the Infusoria, and, in common with your readers, am obliged to Mr. Grenfell for correcting any points in my lecture which may be at variance with recent researches. I may remark, however, that most of the statements which he has contradicted, are to be found

in the pages of Huxley's "Anatomy of Invertebrated Animals," London, 1877, which is still regarded as a reliable work of reference.

The second of Mr. Grenfell's criticisms is quite just; the passage should have read "one *or more* long hair-like processes;" and as regards the sixth, I cannot understand how so obvious an error escaped me when reading the proof.

W. E. HOYLE.

Reviews.

BRITISH ZOOPHYTES: an Introduction to the Hydroida, Actinozoa, and Polyzoa found in Great Britain, Ireland, and the Channel Islands. By Arthur S. Pennington, F.L.S., F.R.M.S. pp. xiv.—263. (London: L. Reeve and Co. 1885.) Price 10s. 6d.

This work is intended to furnish a handy and at the same time a reliable manual of the British Zoophytes, and to do for the present generation what the Rev. Dr. Landsborough did for a former in his Popular History. The author has endeavoured to make it a complete guide to all known British Species, and as far as possible to give an accurate *résumé* of the present knowledge of the structure of the various organisms described. It is illustrated with 24 excellently drawn litho plates by Mrs. Pennington.

THE TECHNOLOGY OF BACTERIA INVESTIGATION. Explicit directions for the Study of Bacteria, their Culture, Staining, Mounting, etc., according to the methods employed by the most eminent investigators. By Chas. S. Dolley, M.D. pp. xii.—263. (Boston, U.S.A.: S. E. Cassino and Co.; London: Trübner and Co. 1885.) Price 10s.

To the student who devotes his attention to the SCHIZOMYCETES, this work will doubtless render valuable assistance. The subject is treated in a very thorough manner. Part I. gives general directions and treats of the living forms, how obtained, etc., Experiments in Culture, in Vaccination and Inoculation, and Biological analysis. Part II.—Special Methods of Investigating Pathological Bacteria in Anthrax, Cholera, Glanders, Hydrophobia, etc., and in Plant Tissues. Part III. gives a great number of Formulæ for Microscopical Investigation, Mounting, &c.

PRACTICAL HISTOLOGY AND PATHOLOGY. By Heneage Gibbs, M.D. Third Edition, pp. xii.—196. (London: W. R. Lewes. 1885.) Price 6s.

The author lays before his readers concise and simple methods by which the various tissues of the body may be prepared for microscopical examination. He gives also the results of his experiments with various colouring agents for double and treble staining. Blank paper is bound up at the end of the book for Memoranda.

Microscopical Diagnosis. By Chas. H. Stowell, M.D., and Louisa Reid Stowell, M.S. Illustrated with 128 engravings and 47 figures on stone, 8vo, pp. 250. (Detroit: Geo. S. Davis. 1882.)

Although this is not actually a new edition we are pleased to have the opportunity of noticing it. The authors, who are editors of the well-known "Microscope," now published at Ann Arbor (U.S.A.), have endeavoured to show in the first part of the work that the Microscope is absolutely necessary in the diagnosis of many forms of disease. Part II. is devoted to Vegetable Histology, in which Wheat, both in the grain and the straw, is largely dealt with. Part III. contains hints on the preparation and mounting of Microscopic objects, and the whole work contains much useful information.

Album of Natural Woods. A very handsome album, consisting of 40 stout cards, each containing three beautifully thin sections of the more important European woods, the size of the specimens being 1¾ in. by 4½ in. These are cut longitudinally, transversely, and tangentially, and are open to inspection on both sides. In addition to the scientific name, they are named in English, French, and German. The whole is enclosed in an elegant Mosaic Wood cover, which is of itself a work of art.

The album may be obtained of M. Wilmersdorffer, 72, Finsbury Pavement, E.C., the price being 25s.

The Chain of Life in Geological Time: A Sketch of the origin and succession of Animals and Plants. By Sir J. William Dawson, C.M.G., LL.D., F.R.S., etc. Second Edition, cr. 8vo, pp xiv.—272. (London: Religious Tract Society. 1885.) Price 6s. 6d.

Since the publication of the first edition of this capital little book, many additions to our knowledge of Fossil Animals and Plants have been made, many new species of which are here described. New facts are also related concerning many species previously known. The volume is illustrated with 192 wood engravings.

Talks Afield about Plants and the Science of Plants. By L. H. Bailey, junr. Cr. 8vo, pp. ix.—178. (Boston, U.S.A.: Houghton Mifflin and Co. 1885.) Price $1.

This interesting little book is written for those who desire a concise and popular account of some of the leading external features of common plants. It treats first of the Fungi, Algæ, Lichens, Mosses, and Ferns: then of some of the more interesting features of the flowering plants, the Flowers and Stems, Classification and Fertilisation, being well described. The volume closes with a chapter on plant names; it is well illustrated.

Our Insect Enemies. By Theodore Wood. pp. xii.—220. (London: Society for Promoting Christian Knowledge. 1885.) Price 2s. 6d.

Our readers will remember that in our last volume we called the attention of our readers to "Our Insect Allies," to which this forms a companion volume by the same author. With the exception of the Aphides, the Author has treated the insects described according to their system of classification, and not with respect to the particular crops which they frequent, but to the *Aphis* four chapters are devoted. The author directs attention to the invaluable assistance rendered by the smaller birds, amongst which we find included the much maligned sparrow.

THE WORLD'S LUMBER-ROOM: a Gossip about some of its Contents. By Selina Gaye. With 57 Illustrations. Cr. 8vo., pp. xii.—316. Price 3s. 6d. (London: Cassell and Co. 1885.)

We find here popularly described some of the ways in which refuse is made and disposed of, first by Nature and secondly by Man. Thus we have described, Dust and Dust Makers, Frost, Heat, Air, Water, etc.; What becomes of Dust, Vegetable Refuse, and Scavengers; Animal Scavengers, Ants, Flies, Beetles, etc.; Household and Miscellaneous Refuse.

SCIENCE IN SPORT made Philosophy in Earnest; being an attempt to illustrate some elementary principles in Physical Knowledge, by means of Toys and Pastimes. Edited by Robert Routledge, B.Sc., F.C.S., etc. Post 8vo, pp. xvi.—332. (London: Routledge and Co.) Price 5s.

Few books will be more agreeable to boys of a scientific turn of mind than this. It is written in the form of a tale, the scientific experiments described being those performed for the amusement and instruction of the boys whilst home for their holidays.

PROPERTIES OF MATTER. By P. G. Tait, M.A., Sec. R.S.E. Cr. 8vo., pp. viii.—320. (Edinburgh: A. and C. Black. 1885.)

This is an introduction to the course of Natural Philosophy taken in Edinburgh, a work in every way worthy of the author, who is professor of natural history in the University. In it the difficult subjects of the ultimate structure of Matter, Time and Space, Inertia, Centrifugal Force, Gravitation, Compressibility of Gases and Vapours, Cohesion, and Capillarity, with many other kindred studies, are treated in the most lucid manner, extracts from original memoirs bearing on the subjects being frequently inserted, and their value discussed in the light of modern research.

UNIVERSAL ATTRACTION: Its Relation to the Chemical Elements; the Key to a Consistent Philosophy. By W. H. Sharp. Cr. 8vo, pp. 53. (Edinburgh: E. and S. Livingstone. London: Simpkin, Marshall, and Co. 1884.)

An attempt to connect the law of gravitation with, and to supersede it by, our present knowledge of chemistry and molecular physics. It is in reality designed to show that "Gravitation" is caused by Wave-Motion, and that "Quantivalence," as known to chemists, is the true measure of "Mass."

ARITHMETICAL PHYSICS.

Acoustics, Light, and Heat.—Part I. A., Elementary, 2s.
Magnetism and Electricity.—Part II. A., Elementary, 1s.
Ditto. Ditto. Part II. B., Advanced, 3s.

By C. J. Woodward, B.Sc. (London: Simpkin, Marshall, and Co. Birmingham: Cornish Bros. 1885.)

These works are in two stages: elementary and advanced. They will be found of much service in class teaching; the examples are well chosen, and afford the teacher good help in testing the real advance of his pupils in the knowledge of the subjects under discussion.

THE WINDMILL AS A PRIME MOVER. By Alfred R. Wolff, M.E. 8vo, pp. xiii.—159. (New York: John Wiley and Son. 1885.) Price $3.

We have here a consideration of the more important features of windmill

theory and practice, sufficient to enable the engineer and user to decide as to the actual state of windmill construction, its history and progress, its probable direction and development, and the degree of economy attained as compared with that of other prime movers. The work is illustrated with a number of well-executed engravings.

ON LIGHT. By George Gabriel Stokes, M.A., F.R.S., etc. Cr. 8vo, pp. vi.—107. (London: Macmillan and Co. 1885.)

This is a second course of the BURNETT LECTURES, delivered at Aberdeen in 1884, the subject being "Light as a means of Investigation." It treats of —I.—Absorption and its application to the Discrimination of Bodies. II.—The Emission of Light consequent thereon. III.—The Rotation of the Plane of Polarisation, of Polarised Light, etc. IV.—The Emission of Light by Incandescent Bodies in a State of Vapour, etc. V.—The information thus afforded as to the Constitution or Condition of Distant Bodies. VI.—The Influence of the Motion of Bodies on the Refrangibility of the Light Emitted, Absorbed, or Reflected by them.

FIELD'S CHROMATOGRAPHY: A Treatise on Colour and Pigments, for the use of Artists. Modernised by J. Scott Taylor, B.A., Cantab. Second edition, cr. 8vo, pp. viii.—207. (London: Winsor and Newton. 1885.) Price 7s. 6d.

To some extent this is a condensed and revised issue of Field's Chromatography, by F. W. Salter, but many of the chapters are entirely re-written. It is a handsome volume; many of the plates are in colours.

CHARLES DARWIN. By Grant Allen. Cr. 8vo, pp. vi.—206. (London: Longmans, Green, and Co. 1885.) Price 2s. 6d.

This is the first of a series of English worthies, edited by Andrew Lang. The author deals with Mr. Darwin as a thinker and worker more than with the biographical details of his private life. The opening chapters deal with the world into which Darwin was born, Darwin and his antecedents, his early days, and his works.

NUMERICAL EXAMPLES IN HEAT. By R. E. Day, M.A. New edition. Post 8vo, pp. vi.—176. (London: Longmans, Green, and Co. 1885.)

This work contains a number of well-chosen arithmetical questions on Heat, including Thermometers, Expansion, Pendulums, Barometrical Corrections, Hygrometry, Latent Heat, Calorometers, and Thermodynamics. A sufficient number of examples is worked out fully to enable the student, with careful study, to test his own knowledge by answering the remainder. We think it a most useful little book.

CHOLERA: Its Origin, History, Causation, Symptoms, Lesions, Prevention, and Treatment. By Alfred Stillé, M.D., LL.D. 8vo, pp. 164. (Philadelphia: Lea Brothers and Co. 1885.) Price $1.25.

The author seeks to exhibit the specific nature of cholera drawn from its origin and mode of propagation, to disabuse the medical profession of the erroneous notion that disease ever originates *de novo*, to maintain the necessity of "quarantine," to point out the channels by which cholera may be diffused, and to describe measures to prevent its dissemination and cure those who are attacked by

it ; and concludes with the remark that if his doctrine be correct, the alleged results of cholera inoculation are deceptive and erroneous. A world-map, showing the cholera routes, is given as a frontispiece.

CHOLERA : Its History, Cause, and Prevention. By Ezra A. Bartlett, M.D. 16mo, pp. 105. (Albany, N.Y. : H. H. Bender. 1885.) Price 30c.

A book written for the people, in which the author states the latest and best opinions on the subject, and whilst expressing his gratification at the reported results of inoculation for its prevention, he feels that for the present our thoughts should be directed more towards sanitation.

THE PHYSICIAN HIMSELF, and what he should add to his Scientific Acquirements in order to Secure Success. By D. W. Cathall, M.D. 8vo, pp. 284. (Baltimore, U.S.A. : Cushings and Bailey. 1885.) Price $2.

This work is written in answer to the supposed question, "What honourable means can I employ in addition to scientific knowledge and book-learning in order to make my success more certain, more rapid, and more complete?" The answer is embodied in the book before us; our only surprise being that many of the suggestions are not thoroughly superfluous, for we cannot help thinking that such would be the case were they addressed to a physician in England. The book is in its fifth edition, so perhaps we are mistaken.

AN INGLORIOUS COLUMBUS; or, Evidence that Hwui Shan and a Party of Buddhist Monks from Afghanistan discovered America in the Fifth Century, A.D. By Edward P. Vining. 8vo, pp. xxiii.—788. (New York : D. Appleton and Co. 1885.)

An immense amount of study and research has been expended on the large book before us. The author, with much force, shows that the country discovered by the Chinese, and to which they gave the name of "Fu-Sang" and "The Country of Women," must refer to Mexico. The map given as frontispiece shows the route followed by Hwui Shan. At p. 262, etc., we have a copy with a literal translation of an extract from the LIANG-SHU, or Records of the Liang Dynasty, in which is given a description of Fu-Sang. The book contains 31 illustrations.

PHILOSOPHIC THOUGHT in All Ages; or, The Bible Defended from the Standpoint of Science. By Lawrence Sluter Benson. Post 8vo, pp. 180. (New York : The Author. 1885.)

In the earlier portion of this work, much thought and extensive reading has been displayed, for here we have epitomised the inmost thought and deep reasonings of learned men of all ages. Perhaps we are somewhat prejudiced in the current beliefs of our own time, but we certainly cannot altogether agree with the learned author in some of his concluding remarks, say after page 141, where he treats of more modern Science.

SCIENTIFIC CULTURE, and other Essays. By Josiah Parsons Cooke, LL.D. Second Edition, cr. 8vo, pp. vii.—293. (New York : D. Appleton and Co. 1885.) Price $1.

Dr. Cooke is Professor of Chemistry and Mineralogy in Harvard College. These essays were written at various times, and are the outcome of a large

experience in teaching Physical Science to college students. They embrace the following subjects :—Scientific Culture ; The Nobility of Knowledge ; Elementary Teaching of Physical Science; The Radiometer, and many others.

PRACTICAL CHEMISTRY, with Notes and Questions on Theoretical Chemistry. By William Ripper. Cr. 8vo, pp, vi.—148. (London: W. Isbister and Co. 1885). Price 2s.

This book, adapted to the revised syllabus of the Science and Art Department, for the elementary stage of Inorganic Chemistry, is divided into two parts :—1.—Elementary Practical Chemistry. 2.—Notes and Questions on the Theoretical Course of Elementary Inorganic Chemistry, intended to supplement the student's MS. notes of lectures, and to be used with or without a text-book. Many of the questions have been selected from the Science and Art and other public examination papers.

HANDBOOK OF PRACTICAL COOKERY. New and enlarged edition. By Matilda Lees Dods, with an Introduction on the Philosophy of Cookery. Cr. 8vo, pp. xxxvii.—299. (London : T. Nelson and Son. 1886.) Price 2s. 6d.

The author aims to give a comprehensive insight into the general rules for the intelligent preparation of food ; and, at the same time, clearly describes the several means and processes of arriving at the desired results. We have tried some of the dishes recommended, and pronounced them "very good."

ALPINE WINTER in its Medical Aspect, with Notes on Davos Platz, Wiesen, St. Moritz, and the Maloja. By A. Tucker Wise, M.D., L.R.C.P., etc. Second Edition, 8vo, pp. 121. (London : J. and A. Churchill. 1885.)

The author describes the various health resorts, with regard to their water, soil, atmosphere, etc. ; he gives also some useful hints on Winter Clothing, Diet, etc. A brief sketch is also added of the walks and drives in the neighbourhood of the Maloja.

FIRST YEARS OF SCIENTIFIC KNOWLEDGE. By Paul Bert, translated by Josephine Clayton (Madame Paul Bert), late of Banff, Scotland. 12mo, pp. 344. (London: Relf Bros. 1885.) Price 2s. 6d.

We are told that in 3 years, 500,000 copies of this book have been sold in France. The translation has been modified to render it suitable to the requirements of English Schools. Its scope is unquestionably a wide one, as it takes in not only the whole of the Animal and Vegetable Kingdoms, but attempts also Stones and Soils, Physics, Chemistry, Animal and Vegetable Philosophy, to which is added a small Dictionary. To those who wish to obtain a knowledge of all the sciences in a week we can recommend this book.

THE KING'S WINDOWS ; or Glimpses into the Wonderful Works of God. By Rev. E. Paxton Hood. With 48 illustrations, cr. 8vo, pp. 278. (London : The Religious Tract Society.) Price 6s.

This beautifully illustrated and beautifully got-up book is the last literary work of its deeply lamented author. The object of the book is to increase the delight felt on looking out on the wondrous beauties of nature, and to develop the habit of using those windows through which something of God's love and tenderness may be seen.

PITCAIRN : The Island, the People, and the Pastor. To which is added a short notice of the original settlement, and present condition

of Norfolk Island. By the late Rev. Thos. Boyles Murray, M.A., F.S. A Revised and brought up to date by the Rev. C. C. Elcum, M.A. Cr. 8vo, pp. xvi.—368. (London: Society for Promoting Christian Knowledge. 1885.) Price 3s.

An interesting account of the Mutiny of the Bounty, and of the early settlers on Pitcairn Island. The book is very nicely illustrated.

LIFE AND EDUCATION OF LAURA DEWEY BRIDGMAN, the Deaf, Dumb, and Blind Girl. By Mary Swift Lamson. Cr. 8vo., pp. xl.—373. (Boston: New England Publishing Company. 1879.)

We have here an account, more particularly, of the education of Laura Bridgman, who lost her sight and hearing, and consequently her speech, through a severe illness, when only two years of age. The method by which she was taught first to read, by means of small blocks of raised type, and afterwards to converse by means of the manual alphabet, are fully described. In process of time she learned to write, and we have a *fac-simile* of her first autograph letter. The book contains also an Heliotype portrait of this interesting girl.

THE DWELLERS ON THE NILE; or, Chapters on the Life and Literature, History, and Customs of the Ancient Egyptians. By E. A. Walter Budge, M.A. Cr. 8vo, pp. 204. (London: The Religious Tract Society. 1885.) Price 3s.

This is Volume VIII. of the By-Paths of Bible Knowledge. A very interesting book, treating of the Decipherment of the Egyptian Hieroglyphics, the Egyptian Language and Writing, the Land of Egypt and its People, etc. The book is nicely illustrated.

QUEER PETS AND THEIR DOINGS. By Olive Thorne Miller. Illustrated by J. C. Beard. Foolscap 4to, pp. 326. (London: Griffith, Farren, and Co.) Price 5s.

The strange doings of some very queer pets are linked together in a pleasing tale. The book is intended for the amusement and instruction of young people, its value is greatly increased by the illustrations, which are mostly drawn from nature; it is printed on fine paper, gilt edged, and the illustrations are good.

FORESTS AND FORESTRY in Poland, Lithuania, the Ukraine, and the Baltic Provinces of Russia. By John Croumbie Brown, LL.D., etc. Post 8vo, pp. viii.—276. (Edinburgh: Oliver and Boyd; London: Simpkin, Marshall, and Co. 1885.) Price 6s.

Those who take an interest in Forestry will find much to interest them in this book. We have first an interesting account of sleigh-travelling in Russia, and of a journey from St. Petersburg to Poland; followed by chapters on Exploitation in Poland, in Lithuania, etc.

FIVE ACRES TOO MUCH: a Truthful Elucidation of the Attractions of the Country, and a careful consideration of the question of Profit and Loss as involved in Amateur Farming. By Robert Barnwell Roosevelt. Cr. 8vo, pp. 309. (New York: O. Judd and Co. 1885.)

This is not a Scientific Book, but it is a very interesting one; a vein of irony, which the author, who is both a sportsman and a scholar, knows well how to use, runs the entire length of the book.

HANDICRAFT FOR HANDY PEOPLE. By an Amateur Mechanic. 12mo, pp. xii.—233. (Dublin: M. H. Gill and Son. 1885.)

Plain and good instructions will be found here on the choice and use of Tools, Carpentery, House-painting, Paper-hanging, etc. Seventy-five illustrations are given. The handy man or youth will find this book useful.

SANITARY SUGGESTIONS; or, How to Disinfect our Houses. Prepared for Popular perusal. By B. W. Palmer, A.M., M.D. pp. 58. (Detroit (Mich.) U.S.A.: Geo. S. Davis. 1885.) Price 25c.

A *résumé* of the latest Information in the Household use of Disinfectants, Deodrants, and Antiseptics; and of Practical Precautions Preventive of Cholera, Diphtheria, Scarlet Fever, and other Infectious Diseases; worth careful reading.

HEALTHY FOUNDATIONS OF HOUSES. By Glenn Brown. 18mo, pp. xi.—143. (New York: D. Van Nostrand. 1885.) Price 50c.

A reprint of a series of papers published in the "Sanitary Engineer." It treats of Natural Foundations, Drainage, Foundation Walls, etc. There are 51 illustrations.

CIVIL SERVICE ARITHMETICAL EXAMINATION PAPERS. By Laurence J. Ryan. 12mo, pp. 153. (Dublin: M. H. Gill and Son; London: Whittaker and Co. 1885.)

This book, now in its 34th thousand, gives examples of questions likely to be met with in Civil Service and Competitive Examinations. The author, a teacher of long experience, believes that if the student will make himself acquainted with all the questions in this book, he cannot fail to receive very high marks in his examination.

INTELLECTUAL ARITHMETIC, upon the Inductive Method of Instruction. By Warren Colbourn, A.M. Post 8vo, pp. xii.—216. (Boston, U.S.A.: Houghton, Mifflin, and Co. 1886.) Price 35c.

In noticing this book, we cannot do better than quote Mr. G. B. Emerson, an eminent Massachusetts educator:—"It evolves in the mind of the learner himself, in a perfectly easy and natural manner, a knowledge of the principles of arithmetic, and the power of solving mentally, and almost instantly, every question likely to occur in the every-day business of common life."

ARITHMETIC. By A. G. Blake, M.A. Post 8vo, pp. 197. (Dublin: Alex. Thom and Co. 1885.)

A practical little book; the various rules are given in so simple a manner, that the learner will have but little difficulty in grasping their meaning. The sums throughout the book are by no means difficult, and we have pleasure in recommending the book for junior schools.

ARITHMETIC PRIMER: A Guide for Elementary Instruction in Arithmetic according to the "Kindergarten" method. By Friedrich Krancke. Translated by Miss Bickell, of Leeds. 8vo, pp. 110. (London: Simpkin, Marshall, and Co. 1885.)

The "kindergarten" is doubtless a capital method for teaching very little children, and the instructions here given are as simple as it is possible for them to be.

A SYSTEM OF RHETORIC. By C. W. Bardeen. Cr. 8vo, pp. xxxix.—673. (New York: O. S. Barnes and Co. 1885.) Price $1.75.

A thoroughly practical book, written, as the author tells us, from the standpoint of one whose daily work for years has been to read, select, and publish manuscripts, who knows from experience the actual difficulties and faults of young writers, and who wishes to help them.

ALEXANDER THOM'S WRITING COPY-BOOKS.

ALEXANDER THOM'S DRAWING-BOOKS. (Dublin: A. Thom and Co.)

A set of these books have been sent to us. We notice that the publishers have broken from the stiff "Copper-Plate" style of our own school-days, and have given us a series of *fac-similes* from actual writing; the letters are well formed without being *painfully* uniform. The writing-books consist of 24 and the drawing-books of 18 pages; they sell at 2d each.

YOUNG ENGLAND: An Illustrated Magazine for recreation and instruction. Roy. 8vo, pp. 572. (London: 56, Old Bailey. 1885.) Price 5s.

We can confidently recommend this Annual Volume as an acceptable present to any boy or girl. Whilst the tales are of thrilling interest, they at the same time convey a moral not likely to be forgotten. The pictures too are sure to please.

INDIAN DOMESTIC ARCHITECTURE. By Lockwood De Forest, 9, East 17th Street, New York. 1885.

A series of 25 very beautiful Heliotype views, size of each page 10½ by 13½, giving views of a House at Ahmedabad in the 16th, another in the 17th, and another in the 18th century; a reduced copy of one of the Bhudder Windows at Ahmedabad (full size being 7 ft. by 10 ft.), made by Mr. De Forest, and sold to the South Kensington Museum. The remaining pictures are equally beautiful. Mr. De Forest has resolved that he will not allow arts to die out, that, with all the advantages of the caste system of the East, have taken centuries to bring to such perfection. Many of the plates show the Mahomedan influence in Rajupatana and Northern India.

Current Notes and Memoranda.

THE SCIENTIFIC ENQUIRER.—We regret that we have been unavoidably delayed in the publication of Part I of this new Journal; it will be ready on 1st February. All Queries, Notes, etc., for insertion, should reach us not later than the 14th instant. From the vast number of letters already received, we feel very sanguine as to the success of our new venture. The price will be 4d., of all booksellers, or 4/6 for the year, free by post.

Wanted.—Members for a Scientific Circulating Magazine Society, which offers the choice of Three Parcels of Magazines for perusal every month.—Address T. F. Uttley, 17, Brazennose Street, Manchester.

COLE'S STUDIES.—Since publishing our October part, we have received Nos. 9, 10, and 11 of each series of the above Studies. No. 12, to complete the vol., will be published about the middle of January. The very excellent character of this work has been well maintained throughout. We have not heard whether a fourth volume will be published.

THE GARNER AND SCIENCE RECORDER'S JOURNAL is the title of a new journal, the first three numbers of which have been received. It is edited by Mr. A. Ramsey, F.G.S., the editor of the SCIENTIFIC ROLL. The GARNER aims to be a Popular Natural History Journal.

Cement for Fixing Wood to Glass.—According to the *Echo Forestier*, a cement for this purpose may be made by dissolving gelatine in hot acetic acid, in such proportions that it solidifies on cooling.—*Chem. Rev.*

Fine Red Ink.—Grind up Carmine in a mortar with a solution of Silicate of Potash, until a uniform liquid is obtained. It must be kept in a bottle closed with an oiled stopper. The ink dries rapidly, and is very brilliant.—*Chem. Rev.*

The Palpi of Insects.—Felix Plateau has recently published *(Bull. Soc. Zool. France)* a series of interesting experiments on the Palpi of Insects, the results of which are quite opposed to the current idea that these oral appendages are essential both to the recognition and seizure of food. He found that beetles, cockroaches, etc., may be deprived of either the labial or maxillary palpi, or both, and still retain the power of identifying and masticating their food. It is very curious that the function of such well-developed organs should so entirely elude us.—*Science.*

No. 11 of Mr. Bolton's Portfolio of Drawings is to hand. It consists of one example in the Vegetable Kingdom, viz., *Synedra pulchella*, on a piece of alga. There are also 14 examples from the Animal Kingdom. A description of the object represented is given at the back of each plate. These Portfolios are published at 1s. each.

Fixing arranged Diatoms and Sections.—Among the many methods of fixing diatoms and other minute objects upon a slide or cover-glass, the method of M. Threlfall has been very highly commended. The diatoms are arranged upon a perfectly dry surface of caoutchouc spread upon the slide, and fixed in place by application of gentle heat. The details may be briefly given as follows:—First prepare a solution of caoutchouc in benzene, adding sufficient caoutchouc to produce a jelly-like mass. Of this take a portion as large as two peas, and dissolve it in thirty cubic centimetres of benzene. This dilute solution is the one that is used. Crude caoutchouc should be used, or such as has not been vulcanized.

This solution affords an easy means of attaching thin sections in series, as well as diatoms, to a glass slip. In either case the slip is coated with a thin layer of caoutchouc, by flowing it with the solution, as a photographic plate is coated with collodion. The solvent rapidly evaporates, leaving the caoutchouc in a thin film on the glass. The sections, ordinarily included in paraffin, are

arranged in series on the caoutchouc. The slide is then warmed to a temperature of 50°—60° C., when the caoutchouc softens, and the sections become fixed in place. The paraffin is then removed by petroleum spirit, and, if it is desired, the sections may be stained in position. To attach diatoms it is only necessary to arrange them on the layer of caoutchouc, and warm gently. This method of fixing diatoms is highly commended by P. Francotte *(Bull. Soc. Belge de Micr.)*.

We have pleasure in stating that "The Naturalist," a Monthly Journal of Natural History for the North of England, Edited by Mr. Wm. Denison Roebuck, F.L.S., and Mr. Wm. Eagle Clarke, F.L.S., will be enlarged in the January and future issues.

To Transfer Prints.—It is said that Printed Engravings may be copied on any paper of an absorbent nature by damping the surface with a weak solution of Acetate of Iron, and pressing in an ordinary copying press. Old writing may also be copied on unsized paper, if wetted with a weak solution of Sulphate of Iron, mixed with a small quantity of Solution of Sugar.

The Hoosier Naturalist.—Edited and Published by A. C. Jones and R. B. Trouslot, Valparaiso, Indiana, U.S.A. We have received the first three numbers of this new magazine, and we certainly wish it much success. It would appear, however, that the publishers scarcely know their own mind as to how to publish it at present. Parts 1 and 2 are 4to, on good paper, part 3, 8vo, very poor paper, but we are told that better paper will be used in future. The articles are interesting.

Castor-Oil Plant.—It is said that flies will not enter a room in which this plant is growing. Our friends will do well to remember this, and endeavour to secure a plant for their parlours before the summer.

Preparing Leaves to show Starch-grains.—A very interesting experiment, showing the influence of light upon the formation of starch in leaves, can be readily performed according to a method recently described by Prof. J. Sachs. To show the starch-grains a leaf must be bleached and made transparent in this way: The fresh leaf is placed in boiling water for ten minutes, after which the chlorophyll is extracted by placing it in alcohol. The colour is thus removed without rupturing the cells which retain the starch. The latter is then made visible by treatment with iodine. The cellular tissues become stained dark blue or lighter, according to the quantity of starch present. Comparative experiments may be made by exposing half of a leaf to sunshine while the other half is protected. A leaf collected in the evening contains much more starch than in the morning.—*Amer. Mon. Micro. Journ.*

The publishers of the "Garner" are about to issue reprints of some of their articles relating to "Local Science;" the first, published at 1½d., will relate to the Mullusca of Sussex.

Kelliot

THE JOURNAL OF MICROSCOPY
AND
NATURAL SCIENCE:
THE JOURNAL OF
THE POSTAL MICROSCOPICAL SOCIETY.

APRIL, 1886.

Charles Darwin.

HIGHBURY MICROSCOPICAL AND SCIENTIFIC SOCIETY.
PRESIDENT'S ADDRESS FOR THE YEAR 1885.
Read before the Society on November 12th, 1885.

By Mr. H. W. S. WORSLEY-BENISON, F.L.S.

IN a Society where not only the science of Microscopy is ably represented, but where from time to time we justify the second part of our title by discussions in the realms of Geology, Zoology, and Botany, I have thought it not inappropriate that I should, as your President for the time being, take as the theme of my address the life and work of one who has done more to revolutionize current error and guide modern thought in the scientific world than any other man of his age.

Therefore, I propose to-night to render some sort of tribute, even though it be but a humble and inadequate one, to the memory of our great scientific leader, Charles Darwin.

I cannot, of course, attempt to sketch his life, or to give you an exhaustive account of all the mighty work which that life accomplished in every branch of natural science. To comprehend that fully, you must diligently read through and through all the 19 or 20 volumes written by Darwin, together with expositions thereon by Huxley, Wallace, and others. I must content myself with presenting you with a very few details of his early years, and with showing you, in brief outline only, the result of his wonderful labours in the sciences to which he devoted his best years and his highest powers.

Surrounded by those whom he very tenderly loved, in his own home near the quiet little village of Down amid the pleasant Kentish hills, at four o'clock on the afternoon of Wednesday, April the 19th, 1882, Charles Darwin passed from amongst us, and finished

"A noble life-work, nobly crowned."

To all who knew, even in small degree, anything of him, the message in the daily papers of April 21st was one laden with sorrow and a sense of loss. When that life ended, there ended one of a man in whose spirit were blended all that is great and all that is beautiful in human nature. The greatest genius, the most prolific thinker, the acutest reasoner, the most brilliant generalizer in the domain of biological science, he was at the same time one who possessed the "child-spirit" in all its exquisite simplicity, one in whom the scientist and the philosopher were exalted and ennobled by the courtesy and kindliness of the true English gentleman.

Charles Darwin was a descendant of two very remarkable families, and in the history of these we can see the "conditioning circumstances which finally led up to the joint production of the man and the philosopher, the thinking brain and the moving energy."

Early in the last century there lived in Nottinghamshire one Robert Darwin, "a person of curiosity," having "a taste for literature and science." He was a member of the celebrated Spalding Club, a friend of Stukeley the antiquary, and appears to have pursued the study of Geology as far as, in that age, it could be pursued. Of his four sons, Robert, the eldest, and Erasmus, the youngest, were authors and students of Botany. Robert issued

a *Principia Botanica*, which reached its third edition. Erasmus was a physician at Nottingham, a man of robust health and untiring energy both of body and mind. In him we find, beyond doubt, the first of the name in whom the Darwinian intellect began to assert itself. He was spoken of in 1731 as "poet, physician, philosopher, naturalist, and philanthropist." Such was the grandfather of the Charles Darwin of our own time. He was the author of the *Botanic Garden*, a work containing two long poems, entitled *The Economy of Nature*, and *The Loves of the Plants*, which, in spite of their rhapsodical extravagances and quaint fancies, are, even in our day, worth reading. Not a few of his "reveries in science" were converted by his grandson into accepted truths. He wrote other books, but it is in his *Zoonomia* that we see the "prophetic sagacity" which was attributed to him rightly enough by his grandson Charles. Prophet he certainly was, and as such was before his time.

> "Soon shall thy arm, Unconquered Steam, afar
> Drag the slow barge, or drive the rapid car,"

said he, years before the first railway-engine astonished the natives. The spread of temperance, the abolition of slavery, the humane treatment of the insane, were all themes of intense interest to him. Prominent among his prophetic utterances, however, are those to be found in his *Zoonomia*, where the titles of many of Charles Darwin's books and the phrases now in universal usage in respect of development are expressed in words of his own. The whole theory of organic development lies in embryo in this book. He saw clearly the unity of parent and offspring, and one sentence of his has in it the germ potential of the theory of descent. "Owing to the imperfection of language," says he, "the offspring is termed a new animal, but is in truth a branch or elongation of the parent, since a part of the embryon-animal is, or was, a part of the parent, and therefore may retain some of the habits of the parent system." He constantly emphasized the hereditary nature of some acquired properties, and carefully sought out any that he heard of from time to time. Although he never saw what was reserved for Charles Darwin to discover, the great truth of 'natural selection,' the agency by which variety is brought about

through modification of pre-existing types, he did in a dim and crude fashion set forth the theory of evolution itself. Erasmus Darwin gave us conjecture coming near the truth, and suggestion fertile and brilliant. Charles Darwin went beyond this, and made suggestion and conjecture unassailable fact, abundantly proven by investigation and experiment. Not that Erasmus did not conduct experiments. He defined a fool as "a man who never tried an experiment in his life;" but he lacked the patience and persistence, as well as the keen reasoning faculty of Charles, and hence he apologized "for many conjectures not supported by accurate investigation or conclusive experiments." Charles Darwin spent 28 years over *one* experiment, which removed him to a fair distance from his grandfather's definition of a fool, and then gave his great theory to the world supported by cumulative proof, the result of untiring, and we may say unequalled observation and experience.

We must not dwell longer here. I have said this much to show the part Erasmus Darwin played in the "conditioning circumstances" that were to bring about the work of his greater grandson.

In 1786, nearly a century ago, Robert Darwin, the third son of Erasmus, settled as a physician at Shrewsbury. He was a F.R.S., and to gain that honour he must have had something worthy of his name in the way of intellect; but, according to his son's estimate of him, which we may be quite sure was a generous one, "he did not possess a scientific mind, but he was incomparably the most acute observer that I ever knew." This power seems to have found exercise mainly in the domain of medicine. In 1796 Robert Darwin married Susannah, daughter of Josiah Wedgwood, the famous potter, and there, in quaint old Shrewsbury, at a house called The Mount, he settled down for fifty years of prosperous and useful life. There, in the Unitarian Chapel, two years later, Coleridge preached his sermon from the text, "He went up into a mountain apart to pray;" a sermon to hear which Hazlitt came through fog and mud from his house at Wem, and said it was "like the music of the spheres!" Robert Darwin was to be envied the society of such men, for Coleridge and Hazlitt were both friends of the Wedgwood and Darwin families. At The Mount, on February the 12th, 1809, CHARLES DARWIN was born.

He was the second son, the eldest being Erasmus, the friend of Carlyle, who "preferred him to his brother Charles for intellect!" Erasmus died in 1881.

Josiah Wedgwood, potter, artist, chemist, road-maker, and school-builder, was a man of enormous energy and wonderful activity, and he possessed that which Carlyle has defined genius to consist of—*i.e.*, "the infinite capacity for taking pains." Speaking of him and of Erasmus Darwin, the elder, Mr. Grant Allen says: "Is it not probable that in their joint descendant the brilliant but discursive and hazardous genius of Erasmus Darwin was balanced and regulated by soberer qualities inherited directly from the profound industry of the painstaking potter? When later on, we find Darwin spending hours in noting the successive movements of the tendrils in a plant, or watching for long years the habits and manners of earth-worms in flower-pots, may we not reasonably conjecture that he derived no little share of his extraordinary patience, carefulness, and minuteness of handicraft from his mother's father, Josiah Wedgwood?"

Charles Darwin was educated at Shrewsbury Grammar School under Dr. Butler, afterwards Bishop of Lichfield. Here he made little mark, and he afterwards looked back on the time spent there as almost wasted, the main portion of it being given to classics, which he very cordially disliked. "*Sum*, *Fui*, *Esse*," were not to his taste, and the little of Euclid which he mastered he used to regard as the only real education he obtained at Shrewsbury.

In 1825, when 16 years of age, he went to Edinburgh University for two years. Up to this time his only passion seems to have been one for "collecting." Eggs, shells, seals, minerals, coins, etc., etc., were assiduously gathered and purchased. At Edinburgh, where he was sent to begin a course of medical education, the first definite evidence of the bent of his life asserted itself. There, on the shores of the Firth of Forth, on the Fifeshire coast, and in the islands round about, he pursued natural science studies with great eagerness, gathering information on every hand both in Botany and Zoology. It was while at Edinburgh that Darwin made his first recorded discovery in science. He found organs of motion in the floating ova of the common *Flustra*, or sea-mat, and read a paper on his discovery at the

Plinian Society on March 27th, 1827, being then a little over 18 years of age.

In 1828 the medical profession was abandoned, and Darwin entered at Christ's College, Cambridge, where his father hoped he would in due time proceed to Holy Orders. This hope was, fortunately, doomed to extinction. He took his B.A. in 1831, coming out tenth among the ὁι πολλοι, and his M.A. was granted him in 1837.

The year 1831 proved an eventful one in Darwin's life-history. Inheriting, as we have seen, considerable taste for natural history, coupled with an indomitable energy in its pursuit, he had the good fortune to find around him at Cambridge several scientific teachers, prominent among them Professor Henslow, the botanist, to say nothing of Ramsay, Airy, Sedgwick, and others. It was natural, therefore, that he should seize with peculiar eagerness on the chances thrown in his way. He did so, and while at Cambridge took up his first really earnest study of Geology. To this partly is due, beyond doubt, his being led towards the question of Evolution as opposed to special creation, and from this time to his death he never lost hold of it.

In the autumn of 1831, almost immediately after taking his degree, occurred the event which made that year famous. The British Government were sending out H.M.S. *Beagle*, under Captain Fitzroy (a man of high scientific attainments) in order to complete the survey of Patagonia and Tierra del Fuego, to define by map the shores of Chili and Peru, and of some islands of the Pacific, and to carry a chain of chronometrical measurements round the world. Fitzroy wanted a competent naturalist to collect and preserve plants and animals during the voyage. He wrote to Professor Peacock, of Cambridge, asking him to recommend a fit person for the post. Henslow was consulted, and instantly proposed his diligent pupil, Charles Darwin, as one "who knew very little, but who, he thought, would work." Darwin accepted the appointment without salary and paid his own expenses in part, only asking that he might retain for himself the specimens that he might collect during the voyage. He left England on December 27th, 1831, returning, after a five years' cruise, on October 2nd, 1836.

To this voyage, and to the use Darwin made of the rich and golden opportunities afforded him, may be traced, through many stages and by slow degrees, the *Origin of Species*, the *Descent of Man*, and to a large extent nearly all his other works. As Grant Allen says, speaking of the countries visited, their glorious scenery and marvellous contents, "This was the real great University in which he studied nature and took his degree. Our evolutionist was *now* being educated."

Before touching at the Cape de Verdes, Darwin had begun his work by observing that the fine dust falling on the deck contained no fewer than 67 organic forms, together with particles of stone so big that they measured "above the thousandth of an inch square"! "After this," says he, "one need not be surprised at the diffusion of the far lighter and smaller sporules of cryptogamic plants." From these islands the *Beagle* passed in due course to Bahia, Rio, Monte Video, and the East coast of South America, on to Buenos Ayres, Patagonia, and the Falklands, to Chili and Peru, to the curious and interesting islands of the Galopagos Archipelago, where our hero found a veritable "happy hunting-ground"; thence to Tahiti and the glorious scenery of Polynesia; on to New Zealand, Australia, Tasmania, and Keeling Island of 'Coral Reef' renown; thence to Mauritius, St. Helena, Ascension, Pernambuco, and 'Home.' A great opportunity and the man ready to use it! "Organism and environment in perfect harmony!" What wonder that with these two so wondrously moulded there should have come into action all that almost superhuman industry, perseverance, patient research, and untiring conquest of difficulty that gave to us the life-work of Charles Darwin?

On his return to England, the history of the expedition was published as a series of volumes together, entitled *The Zoology of the Voyage of the Beagle*, the whole being under his own editorship, the various parts being undertaken by Owen, Waterhouse, Gould, Jenyns, and Bell. The Botanical department was undertaken by Hooker, Berkeley, and Henslow. If we add to all these the volumes that Darwin himself wrote and issued, we gain some idea of the enormous amount of material collected, and the "capacity for taking pains" shown by the great naturalist. The fuller account of the

voyage was published as the *Journal of Researches* in 1839. This was afterwards issued in separate form as *A Naturalist's Voyage Round the World*, Darwin's first published volume, a work whose power to fascinate it is not easy to describe. It must be diligently read to comprehend how entirely the reader yields himself up to the spell of this power.

Soon after Darwin's return he was elected Fellow of the Royal Society. In 1837 he read before the Geological Society a very short paper on the *Formation of Mould*, and 44 years later he published to the world in his final volume the result of his researches in this subject. His uncle, Josiah Wedgwood, had suggested to him that the sinking of stones and other surface material into the earth might be due to the action of earth-worms. In 1842, on some land of his own at Down, he spread a quantity of broken chalk all over the surface of a field to test this theory. In 1871, twenty-nine years later, a trench was dug along the field, and a line of white nodules could be traced seven inches below the surface. Another field, called "the stony field," was turned into pasture in 1841, and Darwin wondered if he should live to see the flints covered. In 1881 a horse was galloped across this field without striking a stone with its hoofs!

Is it astonishing that a man who could work like this, and wait 40 years to prove his theory, could do anything he chose to undertake in logically testing a scientific truth?

In 1838 Darwin read at the Geological Society his paper on *The Connection of Volcanic Phenomena with the Elevation of Mountain Chains;* when, as Lyell said, "he opened upon De la Beche, Phillips, and others, the whole battery of the earthquakes and volcanoes of the Andes." In the same year, at the early age of 29, we find him filling the honourable post of Secretary to the same Society.

In 1839 Darwin married his cousin, Miss Emma Wedgwood, and after a very short residence in London settled at Down House, near Down, in Kent. Here he spent the remaining forty years of his life. Of these forty years, his published works, to which we shall presently refer, tell the tale. He was rarely seen away from home, but was one of the speakers at the Oxford meeting of the British Association in 1847, when Robert Chambers read a

paper, and John Ruskin acted as Secretary of the Geological Section.

In his quiet, comfortable home he sat at the feet of the 'Great Mother,' looking steadfastly into her countenance until he read the inmost secrets of her heart, and wrested from her the hidden evidence of the grandest and most sublime miracle, natural and yet Divine, that she has ever given to man. There, in spite of ill-health, brought on by perpetual sea-sickness during the *Beagle* voyage, from which he never recovered, he worked steadily and patiently on among his fowls and pigeons, his plants and insects, seeing how the worms liked candle-lights and pianos, how pitcher-plants greedily devoured unwary insect intruders, and the like. To bed at 10 p.m. and up at 5 a.m., he was very often at work by 8 a.m., after an early walk and breakfast. I need not say that *he worked by system.* No man could have accomplished that 40 years' labour except by this plan. "In preparing all his books he had a special set of shelves for each, standing on or near his writing-table, a shelf being devoted to the material destined for each chapter." With all his work he invariably devoted part of every evening to sitting with his family, chatting over various subjects, or listening to the novel read aloud by Mrs. Darwin or one of the children. He was no less great as husband and father than he was as scientist and philosopher. To his patient and loving instruction his sons, George and Francis, owe much of their present success and undoubted ability in research.

Before I refer briefly to his services in the different sciences, it will be well to remove one or two misconceptions that exist concerning him in the *popular* mind, at all events, and to see also what was the state of things in respect of evolutionary science at the time when he astonished the whole civilised world by the issue of his *Origin of Species.* Many people regard Darwin as the *founder* of the great evolutionary hypothesis. They believe that he was the first to arrive at the idea of all plant and animal forms being the outcome of slow modification of pre-existing types, and not of 'special creation.' They believe, too, that he first propounded the theory which supposes that man can be *physically and anatomically* traced back through remote ages to an ancestry more or less akin to the Anthropoid apes. He was not the

originator of either of these hypotheses. He held them both as articles of scientific faith, but they existed before his time, and he never claimed their authorship. Darwin's grand discovery was not 'descent with modification,' but that of 'natural selection,' the *agency* by which, "as he was the first to prove, definite kinds of plants and animals have been slowly evolved from simpler forms, with definite adaptations to the special circumstances by which they are surrounded." An abstract of his theory can be given in half-a-dozen concise sentences :—

1.—More organisms are produced than can survive.

2.—The fittest survive, *i.e.*, in the struggle for existence.

3.—No two are alike—the tendency is to variation due to sundry causes.

4.—Variations are transmitted.

5.—Variations must be in harmony with surroundings. This is the very essence of natural selection.

6.—Variations repeatedly produced result finally in new species.

7.—Ages of time must be postulated as necessary for the various changes and developments from the primitive organism up to Man.

All these steps in the process of descent by modification through the agency of natural selection can be proved from Embryology, Morphology, Geological succession, Geographical distribution, and Classification, as well as by our own application of the theory in the variation of plants and domestic animals.

Thus Darwin *did not* discover 'descent by modification,' but he *did* discover the machinery by which such a result could come about. To quote Grant Allen's way of putting it: "He was not, as most people falsely imagine, the Moses of evolutionism, the prime mover in the biological revolution ; he was the Joshua who led the world of thinkers and workers into full fruition of that promised land which earlier investigators had but dimly descried from the Pisgah-top of conjectural speculation. Darwin raised this theory from the rank of a mere plausible and happy guess to the rank of a highly elaborate and almost universally received biological system."

The doctrine of the 'Fixity and Immutability of Species,'

which was almost universally held up to the close of the 18th century, was that every species of animal and plant originally existed in, and owed its present form to, a special act of creation. No variation of importance had occurred between the types; the plants and animals individually kept their original form quite unchanged down through the ages.

This crude belief was supported in popular thought by some verses in the 1st chapter of Genesis, and no one ever paused to think whether the words in Genesis really presupposed any such notion. They did not stay to enquire whether the author, whoever he was, was a scientific man, or whether he wrote for a scientific age or not, but accepted the doctrine preached without gainsaying. This is the less to be wondered at, because the wonderful variety of living beings and their variability, known in our time well enough, were then unknown, especially to ordinary observers. I need not stay, here and now, to point out the foolishness of adhering to such a belief in the teeth of overwhelming evidence to the contrary, or the unwisdom of any man who, "before distinguished audiences at the Mansion House" and elsewhere, tries to prove the exactest accord, even in minutest detail, between 'Moses and Geology.' Suffice it that I have said that this doctrine of 'Fixity and Immutability' prevailed up to 1800 or thereabouts.

Linnæus gave the weight of his authority to this belief, and, so far as we know, never accepted any other. Buffon, first among the great naturalists, was the one to timidly suggest the doctrine of modification. He pointed out that under external differences there were fundamental likenesses suggestive of common origin, and yet so strong was the power of the then accepted teaching that he used to say, "No, it cannot be after all;" indeed, we are told that once, at least, he had "to submit and demand pardon from the offended orthodoxy (?) of the Paris faculty." His suggestion, however, did bear fruit. "The startling plop of Buffon's little smooth-cut pebble," as Grant Allen calls it, caused a wave of thought and investigation, whose circles spread wider and wider, and we may question if even yet the outermost circle has found its shore. Geoffrey St. Hilaire, Goëthe, and Erasmus Darwin each independently saw the probable truth of Buffon's theory. It was reserved for Lamarck, in 1801, to fully take up the subject and

bring about a state of affairs in which the earnest attention of all scientific thinkers was directed to the probability of *change* being the result of *law* rather than of spasmodic miraculous interposition. He made the scientists of his time begin to see that, as Emerson says :—

> " The world was built in order,
> And the atoms march in tune."

It was his *Philosophie Zoologique* that touched to its very centre the course of evolutionary research all over the science world, and not even the genius of the immortal Cuvier himself brought to bear against the doctrine could stifle it in its slow but certain growth.

Geology and Astronomy were not less moved than was Biology by the on-coming wave. Murchison, Sedgwick, Buckland, Lyell, Phillips, De la Beche, Agassiz, Kant, Laplace, and Herschell were all, consciously or unconsciously, contributing to the massive phalanx of discovered facts that went to support the modification hypothesis, some of which facts could be explained by this hypothesis only, and which, dim and unsuggestive without it, were bright and significant in its brilliant light.

Into such a world of science and philosophy Charles Darwin was born in 1809. What wonder, that coming from the families I have named into an atmosphere where men of the profoundest powers of research and thought were busy looking into this newly discovered evolutionary realm, he, endowed with a Divinely-given genius, should have set himself to find out the 'why' and the 'how' of the doctrine which had already found wide acceptance ? All around him he saw men who were building up the theory of slow modification from previous types into a grand and glorious certainty ; it was for him to make known the one thing needful to its final adoption—the means by which this age-long process had been and was being accomplished. Let me quote in full, for the sake of its own beauty and completeness, Grant Allen's picture in words of the scientific world when Darwin came into it, before we try to see the work he performed :—" On every side evolutionism in its crude form was already in the air. Long before Darwin himself published his conclusive 'Origin of Species,' every thinking mind in the world of science, elder and younger, was

deeply engaged upon the self-same problem. Lyell and Horner were in alternate fits doubting and debating. Herbert Spencer had already frankly accepted the new idea with the profound conviction of *à priori* reasoning. Agassiz was hesitating and raising difficulties. Treviranus was ardently proclaiming his unflinching adhesion. Oken was spinning in metaphysical Germany his fanciful parodies of the Lamarckian hypothesis. Among the depths of Brazilian forests Bates was reading the story of evolution on the gauze-like wings of tropical butterflies. Under the scanty shade of Malyan palm-trees Wallace was independently spelling out in rude outline the very theory of survival of the fittest which Charles Darwin himself was simultaneously perfecting and polishing among the memoirs and pamphlets of his English study. Wollaston, in Madeira, was pointing out the strange adaptations of the curious local snails and beetles. Von Buch, in the Canaries, was coming to the conclusion that varieties may be slowly changed into permanent species. Lecoq and Von Baer were gradually arriving, one by the botanical route, the other by the embryological, at the same opinion. Robert Chambers published in 1844 his 'Vestiges of Creation,' in which Lamarck's theory was impressed and popularised under a somewhat spoilt and mistaken form. It was not till 1859 that the first edition of the 'Origin of Species' burst like a thunderbolt upon the astonished world of unprepared and unscientific thinkers."

Having thus attempted to show you something of the man and his antecedents, and briefly indicated the general position of the world of science into which he came, I wish in the time remaining to me to place before you quite simply, and in outline only, a sketch of the wondrous work Darwin did in the various sciences during those 40 years of retirement in Down House. I purpose, in order to do this, to name the volumes and to point out the general drift of each in relation to the Science with which it is specially concerned.

Geology.—In this science Darwin's work has exercised at least as great an influence as that of any man of his age. Besides the papers already referred to as having been read at the meetings of the Geological Society, he issued three volumes dealing with the geology of the *Beagle* voyage. In 1842 appeared the first, *The*

Structure and Distribution of Coral Reefs, a now recognized classic in geological literature. It is a masterpiece of scientific method. Every fact that Darwin had observed is duly marshalled, and step by step, through cautious watching and crucial experiment, we are led up to the grand conclusion that 'fringing-reef,' 'barrier-reef,' and 'atoll' are to be explained by the gradual subsidence of parts of the bed of the Pacific; nay, more, we are shown in the author's own matchlessly logical style that the fringing-reef of yesterday becomes the barrier-reef of to-day, and the barrier-reef of to-day is destined to be the atoll of to-morrow.*

In 1844 he followed with his second work, *Geological Observations on Volcanic Islands*, in which we are told the story of the gradual upheaval of those islands. In 1846 he published the third of this series, entitled *Geological Observations on South America*, in which he deals with the slow and oft-interrupted rise of that country during recent geological time, tracing the marine shells for more than 2,000 miles along the coast, and to as high a level in certain spots as 1,300 feet. In addition to these three volumes, concerning the first of which Geikie says, "This treatise alone would have placed Darwin in the very front of investigators of nature," we have his papers on *Erratic Boulders in South America*, on the *Geology of the Falkland Islands*, and a very celebrated one in 1843 on *British Glaciers*, the result of a visit to Snowdon and its district. Our record is imperfect unless we include here his chapter on the *Imperfection of the Geological Record*, and the two on *Geographical Distribution* in the *Origin of Species*. It is almost impossible to rightly estimate the importance of these three chapters, or their influence on the geological questions of our time, especially as showing how much of palæontological fact can be readily explained by Darwin's great theory, and how the presence of groups of organisms can be made to tell us the history of the long-continued interchanges of land and sea.

BOTANY.—With his accustomed and innate modesty, Darwin always said that he was not by any means a botanist. Perhaps he was not one in the 'dry-as-dust' sense of the term, and we are thankful that he was not. To the science of Botany, however, he

* See note at end of paper.

made more numerous and more important contributions than any known botanist, for the very good reason that—as in all other pursuits—he went below and behind mere classification and collection, and found out the hidden secrets of plant life; not only telling us the *reasons* of a multitude of well-known but unexplained facts, but also bringing to light a vast array of hitherto unknown life-histories in the plant domain.

In 1862 the botanical world was at once surprised and delighted by his volume on the *Fertilization of Orchids*, in which are chronicled the results of almost endless experiments carried on with the love of accuracy that so distinguished Darwin. The first 44 pages of this book no student of the science should leave unread, and I will answer for it that the remainder of the volume will not be left unstudied. The whole treatise is an introduction into a veritable "Fairy-land of Science," and we put it down with the feeling that the wonderful flowers have been transformed into personal friends, a sentiment which, I believe, Darwin himself often possessed.

The Movements and Habits of Climbing Plants followed in 1865, in which the evolution of the various 'climbers,' from the earlier existing 'twiners,' and of 'tendril bearers' from 'climbers,' is admirably worked out. The details of this paper I have in a former paper placed under your notice.

In 1868 appeared the two volumes called *Variation of Animals and Plants under Domestication*, for the materials of which the whole universe was literally ransacked. All the literature of agriculture and horticulture, of the breeding of horses, cows, dogs, cats, fowls, and pigeons, besides an enormous list of magazines, reviews, journals, newspapers, and treatises were laid under contribution for the preparation of this work. It is utterly impossible to do more than name it.

In 1875, 1876, and 1877, with a capacity of production that showed more than ever his fertility of resource, power of observation, unsurpassed accuracy, and care for detail, he gave us *Insectivorous Plants*, *The Effects of Cross and Self-Fertilization in the Vegetable Kingdom*, and *Different Forms of Flowers on Plants of the same Species.* In the first we were told the story of the Venus' Fly-trap, Sundew, Butterwort, Bladderwort, and

other marsh and bog plants, in relation to their insect prey. In the second he shows that nature abhors self-fertilization, because it ultimately leads to degradation and extinction, and that cross fertilization produces the best offspring in respect of growth, strength, and fertility, proving that in spite of the fact that most flowers are hermaphrodite, there is usually some provision for the transference of pollen from the flowers of one plant to another of the same species. In the third he proved that the different positions of stamens and pistil in the flowers of even a single plant, in such cases as those of Primrose, Cowslip, Loose-strife, and Flax, was really in order to ensure cross-fertilization, and to render self-fertilization impossible, thus securing an abundant, healthy, and vigorous offspring.

In 1880, when 71 years old, Darwin issued a book on the *Power of Movement in Plants*. Here he traced the windings of the tiniest rootlets and stems, and assigned to these their cause and effect; still further, he investigated the wonderful phenomena seen in such plants as Mimosa (the Sensitive plant), and others whose leaves are said to "sleep," and taught us the meaning of the "sleep" in all these cases, as well as leading us to see the relation of the opening and closing of flowers to different times of day or night, to varying seasons, and to geographical *habitat*. No more interesting volume came from his pen than this one from many points of view.

Finally in 1881, only a short time before his death, his last work on the *Formation of Vegetable Mould*, to which I have previously referred, was in a sense as much related to botanical science as it was to that of Geology.

Zoology.—The *Naturalist's Voyage* of course abounds with zoological facts and especially deals with geographical distribution of species, but in 1851 and 1844 were published the only *purely* zoological works that Darwin wrote. These were 2 volumes issued by the Ray Society, one on *Recent Barnacles*, and a second on the Fossil species of the same family. They were together called *A Monograph of the Cirripedia* and proved abundantly that had he resolved to devote his life to pure Morphology only, he would indubitably have taken a foremost place as an anatomical investigator.

I cannot give here even an epitome of the *Origin of Species* (1859), the *Variations of Animals and Plants under Domestication*, or the *Descent of Man* (1871), all three of which books are more or less zoological; to the second of these I briefly referred under the head of Botany; neither can I go further than to say that we find the marks of Darwin's genius not only in the three sciences already named, but also in that of

PSYCHOLOGY.—His book entitled *The Expression of the Emotions*, published in 1872, together with a single chapter in the *Origin of Species* and three in the *Descent of Man*, are all nearly related to this science. To these we must add what I believe was his last-written paper, published in *Mind*, on the *Psychogenesis of a Child*, an Essay on Infantile Intelligence.

I have said enough to show the wide-reaching grasp of his mighty intellect and the debt that all the world of sciences owes to his labours.

Regarding his greatest work, *The Origin of Species*, and that which twelve years afterwards followed it, *The Descent of Man*, I need only say a few words. For the most admirable and masterly epitome and exposition of these books I refer any of you to the lately-issued volume, 'Charles Darwin,' by Grant Allen, forming the first of 'English Worthies.' Pages 58-143 of this beautiful tribute to Darwin's memory will charm every reader of them.

We are all more or less familiar with the story of the *Origin of Species*. The "idea" of the work occurred to Darwin in 1837. *After five years' collecting of facts*, he "allowed himself to speculate on the subject, and drew up some short notes;" in 1844 he enlarged these into "a sketch of probable conclusions;" from then up to 1859 he "steadily pursued the same subject." Twenty-two years did Darwin wait before he ventured to send forth his epoch-making book! And yet the *Quarterly Review*, by way of a monstrous perversion of truth, charged him with "a continually growing neglect of the facts around him;" and the *Edinburgh Review* warned the members of the Royal Institution (who had listened to Huxley's favourable lecture on the book) against such "abuse of science"!

The immediate cause of the issue of the book must not be

passed over without notice. In 1858 Wallace was working at the Natural History of the Malay Archipelago, whither he had gone in 1854. He sent home to Darwin a memoir, in which it was found when the latter opened it that Wallace had independently arrived at the same conclusion regarding the Origin of Species, namely, that 'natural selection' was the great factor in the process. The letter accompanying the memoir requested that Darwin would forward it to Sir C Lyell for presentation to the Linnean Society. What did Darwin do? He at once sent it with strong and generous commendation to Lyell, who sent it on to the Society. Lyell and Hooker, who were both aware of the fact that Darwin had come to a similar conclusion, backed up by more than twenty years' gathering of detail and fact, advised him to issue a digest of his own work side by side with Wallace's paper. He did so, and the two papers were read on the same evening, July the 1st, 1858, before the Linnean Society. The story of this double recognition of a rival's worth is one of the brightest records in scientific renown. It is to the immortal honour of both men. "The elder naturalist never strove for a moment to press his own claim to priority against the younger; the younger, with singular generosity and courtesy, waived his own claim to divide the honours of discovery in favour of the elder. Not one word, save words of fraternal admiration and cordial appreciation, ever passed the lips of either with regard to the other"! After the reading of the papers, Darwin diligently laboured to finish the first great work that was destined to such fame, and on November the 24th, 1859, a date not to be forgotten, the *Origin of Species* was presented to the astonished world.

We all know the result. Atheist, Materialist, Iconoclast, Ishmaelite, were among the mildest epithets hurled at him and his work by men who knew absolutely nothing about it. At the Oxford meeting of the British Association a stormy debate was held on it, when Henslow, Darwin's old friend and tutor, presided over the Biological Section for the last time. A grand passage-at-arms was witnessed between Bishop Wilberforce and "young Huxley," who warmly defended the book and its author. It was Huxley, who, when asked by one of the opponents whether he was related on the paternal or maternal side to an ape, replied that if

he had his choice of an ancestor, whether it should be an ape, or one who, having received a scholastic education, used his logic to mislead an untutored public, he should not for one moment hesitate to choose the ape! The crowded audience, which began by loudly cheering the onslaught on Darwin, ended by cheering Huxley to the echo.

For long the storm raged in pulpit and in press. One of our great political leaders declared himself "against Mr. Darwin and on the side of the angels"! Even the Royal Society waited until 1864 before it bestowed on him the Copley Medal. In two months a second edition of his book was called for and issued. Gradually the storm abated, Darwin all the time bearing himself nobly, quietly, generously, courteously, alike to friends and foes. Very soon the leading scientists one by one enrolled themselves on his side. Hooker, Lyell, Spencer, Huxley, Henslow, Asa Gray, Fiske, the Müller brothers, and others, all avowed themselves evolutionists and "Darwinians." Later on Tyndall and Allen Thomson joined the array. In due time a younger regiment of workers, who for years had sat at the feet of the great master in science, declared themselves his disciples and accepted his theory. Balfour, Romanes, Lubbock, Ray Lankester, Thistleton Dyer, Andrew Wilson, Grant Allen, are among the most popular exponents of his grand discovery. In 1880, when in all quarters of the globe Geology and Palæontology, Zoology and Botany, were yielding unassailable evidence of the truth of the evolutionary doctrine, Huxley delivered that masterpiece of eloquence at the Royal Institution on the *Coming of Age of the 'Origin of Species,'* and was able to say, "Evolution is no longer a speculation, but a statement of historical fact." So, after 21 years of storms and calms, of opprobrium and approval, the great crowning victory came to the earnest, patient worker, and Charles Darwin took his only proper place amongst his peers—king over them all.

To the last he set an example of a noble and beautiful life, which had, as Dr. Carpenter, so lately gone from us, finely said, "no 'other side.'" He had, as Huxley tells us, "an intellect which had no superior, and a character which was even nobler than the intellect." Grant Allen writes:—"His conspicuous and beautiful love of truth, his unflinching candour, his transparent

fearlessness and honesty of purpose, his child-like simplicity, his affectionate disposition, his modesty of demeanour, his kindliness, his courtesy to opponents, kindled in the minds of men of science everywhere a contagious enthusiasm, only equalled, perhaps, among the disciples of Socrates."

On the 26th of April, 1882, he was laid to rest in Westminster Abbey, close to the grave of Sir Isaac Newton—a worthy resting-place, by the side of the man he equalled!

The Dukes of Devonshire and Argyll, Russell Lowell, Lord Derby, Spottiswoode, Hooker, Wallace, Huxley, Lubbock, and Farrar were his pall-bearers. The anthem composed for the occasion, "Happy is the man that findeth wisdom," was singularly appropriate, and not less so was that sung at the grave of him around whose head so many storms had sounded, "His body is buried in peace."

After his burial a hue and cry was raised by some self-constituted guardians of 'truth,' because, said they, he wrote, "I do not believe that any Revelation has ever been made." *They* put the full stop, and then said that "he discredited the Scriptures of Almighty God." What was it that he did say? "I do not believe that any Revelation has ever been made as to the *nature* of the future life." A very different sentence from that imputed to him by his impertinent critics! You need only go to 'In Memoriam' to find very similar words in reference to the raising of Lazarus. When the Duke of Argyll asked him, shortly before his death, if he did not think the discoveries he had made could only be understood as the effect and expression of *mind*, he looked at the Duke for a moment, and said, "Well, it often comes over me with overpowering force, but at other times it seems to drop" —words only showing us how to the greatest minds there comes a veil of mystery hiding the truths behind it, the faith of such minds being all the stronger and surer for the darkness, when God lifts a corner of the veil and reveals Himself. Depend on it, Darwin pondered during his long life the problem of a future one more anxiously than many who loudly declaim him because he was not afraid to say he could not solve it. Does he not say in so many words, "A man may be an ardent Theist and also an Evolutionist. Kingsley and Asa Gray were both. I have never, in my extremest

fluctuations, been an Atheist; the term 'Agnostic' (in the sense of being unable to comprehend God) comes nearer to defining my position, and that only at times, but more so as I grow older."

He has solved the problem now! And who dares to say that he is not at rest with the Master, the Creator of the worlds whose wondrous potentialities and forces he so loved to study and think of, alone with God!

And yet of this man such lines as the following are written in 1883 in sober earnest:—

> "Darwin believes man but a beast,
> Sprung from a lowly root;
> Superior to frogs and apes—
> A highly-cultured shoot;
> Forerunner of a higher race—
> But not what Scripture states,
> Possessed with an immortal soul;
> On *minds like his* that grates."

Who gave Miss Georgiana Farrar, the author of the above and of some six or seven thousand other verses, authority to state that Darwin disbelieved in an immortal soul? If she possessed a fraction, infinitesimally small, of the *mind* she sneers at, she would have spared the much-enduring public the infliction of such unmitigated twaddle, and her publishers the probable loss on the first and (let us hope) only edition of her poems.

Moreover, we hear of a "Society for the Suppression of Blasphemous Literature," and funds are being collected to prosecute Messrs. Huxley, Tyndall, Spencer, Argyll, Lubbock, and Martineau for their blasphemies, Darwin being omitted only because he has passed from human grasp. How strangely true is it that religious fanaticism does sometimes border on insanity!

While Darwin lived, patiently watching in his peaceful Kentish home, the birds, insects, and worms, the flowers, trees, and fields, that all had voices for him, laboriously, carefully, cautiously, through all those years gathering up his facts, uttering no word concerning any of them until anticipation had become certainty, the critics were busy all around him; Exeter Hall rang with protestations against him and all his works, as if he were the very "Anti-Christ" incarnate, and his *Origin of Species*, the result

of nearly 30 years' unceasing work and research, was sneered at as "half-digested facts" by men who pattered sermons and scrawled volumes at almost the same rate with which the *Times* printing-machines provide us with our daily budget of news.

The heathen raged furiously, and shouted, "He blasphemeth!" Listen to one sentence of the so-called "blasphemy"! "It is not more irreligious to explain the origin of man as a distinct species, through the laws of variation and natural selection, than to explain the birth of an individual through the law of ordinary reproduction. The birth of the species and of the individual are equally part of the grand sequence of events which the mind refuses to accept as the result of blind chance. The understanding revolts at such a conclusion." Noble, earnest, wise words such as these were "blasphemy," and they who so miscalled them preferred, I suppose, the conception of creation emanating from the fertile brain of an American Divine, "God Almighty once took some nothing, and in a week produced the universe as it stands, and one man"! Others said they could "make short work of the absurd theory of modification." Anyone who can make "short work" of Darwin may, as Mr. Grant Allen says in a letter to myself, "be safely neglected." As Mr. W. S. Lilly reminds us in the *Fortnightly* for January, 1886, such men should remember a precept of the Talmud, "First understand—then argue;" and that "A *fact* is not altered by a hundred texts."

Now Darwin has passed away. His pen is laid aside for evermore. His mighty genius has gone to be made yet more glorious in another sphere! Behold the transformation! He, who hailed with delight a discovery by Wallace, Lyell, or any other observer, and yielded them homage, born of his great, sympathetic, unselfish nature, is exalted to the position of one "who reverenced his conscience as his King," who loved and sought the truth, who willingly disturbed the faith of no man—a great discoverer, a noble philosopher, an English gentleman; preachers and writers speak true and loyal words in his praise, and Westminster Abbey opens her avenues to receive his remains into her guardian care, followed by a princely retinue of England's greatest divines, scholars, and scientists.

I am deeply conscious of the poverty of this tribute of reverence for the life and work of the greatest man of our century. The wreath I place on his tomb is only one of modest wild flowers, grouped by an unartistic hand; but it is the outcome of sincere admiration and respect for the memory of one who, from my boyhood upwards, has been my ideal of all that is noble, patient, earnest, and lofty in human nature.

Let Grant Allen's own words finish the story—I know none worthier with which to close any estimate of such a man:—"Charles Darwin was a great man, and he accomplished a great work. The Newton of biology, he found the science of life a chaotic maze; he left it an orderly system, with a definite plan and a recognizable meaning. Great thoughts like his do not readily die; they expand and grow in ten thousand bosoms till they transform the world at last into their own likeness, and adapt it to the environment they have themselves created by their informing power. Alone among the prophets and teachers of triumphant creeds, he saw with his own eyes the adoption of the faith he had been the first to promulgate in all its fulness by every fresh and powerful mind of the younger race that grew up around him. The Nestor of Evolutionism, he had lived among two successive generations of thinkers, and over the third he ruled as king. With that crowning joy of a great, a noble, and a happy life, let us leave him here, alone in his glory."

Sutton, Surrey; November, 1885.

NOTES.

I must express my obligations to many authors in the preparation of this paper: prominently among these to Professor Huxley, Mr. Herbert Spencer, Hermann Müller, Fritz Müller, Mr. A. R. Wallace, Mr. H. W. Bates, and Dr. A. Wilson.

From the works of Charles Darwin himself I need scarcely say I have derived the choicest material of all, as coming from the fountain-head of evolutionary science.

To many others I might also confess myself indebted for valuable information as to the influence of Darwin's work on biology as a whole; but my special and grateful thanks are due to three authors, from whom I have gleaned many facts, and whose words I have largely quoted. I refer to Mr. Romanes, the writer of 'Charles Darwin' in the 'Nature Series'; to Mr. Woodall, for his Memoir issued in the 'Transactions of the Shropshire Archæological Society'; and most of all to Mr. Grant Allen, the author of the lately published book, 'Charles Darwin' in the series of 'English Worthies.'

Referring to Darwin's work in Geology, and more especially to his work on *Coral Reefs*, on page 82, I wish to add that I used the words, "recognized classic in geological literature" quite advisedly; but it is only right to advert to the fact that the more recent researches of Murray and Agassiz in 1880 and 1883 respectively would appear to force us to conclude that we cannot now accept Darwin's theory as offering a complete solution of the problem of these reefs. For an admirable digest of the researches of the naturalists above named, I refer my readers to the two papers on the *Origin of Coral Reefs*, by Professor Geikie, in *Nature*, vol. xxix., pp. 107 and 124.

H. W. S. W-B.

Fresh-Water Algæ.

By George Norman, M.R.C.S., &c.

Part II.

Plates 9, 10, 11.,

Class I.—Protophyta.

In this class we commence with the simplest form of plant-life—a little mass of protoplasm, with or without a cell wall. The cell-wall is usually to be found, but when the plant assumes an amœboid condition the cell-wall is absent. An example of this is

to be found in the widely-distributed *Protococcus pluvialis*, which may be found in almost any house-gutter. An allied species, *Protococcus nivalis*, the so-called red snow, was long supposed to be confined to the arctic regions and to snow mountains, but it has been found in this country on the borders of lakes, especially affecting calcareous rocks.

Glœocapsa shows a little advance in organisation, the thallus being gelatinous and enclosing cells and families irregularly disposed, and presenting fine example of cell division. The colour of the cell contents is sometimes greenish yellow, but more commonly red; *G. sanguinea*, an example of the latter, is a favourite slide with microscopists.

There are numerous other simple genera included under this class, but it is probable that many of them are not independent species, but only stages in the development of some higher form, and that in course of time such families as the *Palmellaceæ*, *Protococcaceæ*, and *Chroococcaceæ* will disappear altogether from the catalogue.

As we go up in the scale we find the derivative cells, instead of separating and carrying on an independent life, remaining united and forming slender rows of cells, or thin lamellæ.

Thus in the Nostocs we find a more or less firm jelly, in which chains of small rounded cells are imbedded, with here and there a large cell, termed a heterocyst, which has to do with the propagation of the species. Some of the Nostocs are supposed to be parasitic (especially *Nostoc lichenoides*), and are described as such in the leaves of Hepaticæ and Mosses, by various French and German observers.

The *Oscillariæ* consist of rigid cylindrical filaments of varying thickness, divided into disc-like cells by delicate transverse septa. The filaments are straight or a little curved, rarely spirally convolute, and mostly brightly coloured in various shades of green and blue; they revolve on their axis, and on this account the filaments often get matted together in large masses.

O. ærugescens is mentioned by Dr. Drummond as existing in such quantity in Glasslough lake, Ireland, as to impart a decided green tinge to the water. The plant seemed diffused all through the water of the lake, but in a ditch extending from the lake he

found large masses of it, several inches thick and above a foot and a half in length.

O. thermalis has been described by Hassall as having been found in warm water, and *O. tenuissima* as peculiar to the Bath Mineral Water, but neither species has been identified by Cooke.

In *Rivularia* the frond has a tendency to a hemispherical or bladdery form, the filaments of rounded cells are agglutinated by mucilage and radiate from the base of the frond; at the free end the filament runs out into a long hyaline hair, while at the central end is a large heterocyst, which gives the whole filament the form of a riding whip.

This is one of the Algæ associated with the phenomenon called "Breaking of the Meres," which is thus described by Professor Dickie in his "Botanists' Guide:"—"For some years excursions were made with students of my botanical class to a loch on the estate of Parkhill, about four miles north-west from Aberdeen. The sheet of water in question is about a quarter of a mile in its greatest length; on almost all sides it is surrounded by extensive deposits of peat, with the soluble matter of which a great proportion of the water passing into the loch is impregnated. The locality was generally visited in the beginning of July. Nothing particular had ever been observed till the summer of 1846, when my attention was arrested by a peculiar appearance of the water, especially near the edge, but extending also some distance into the loch. Numerous minute bodies, with a spherical outline, and varying in size from 1-24th to 1-12th inch in diameter, were seen floating at different depths, and giving the water a peculiar appearance. In some places they were very densely congregated, especially in small creeks at the edge of the loch. A quantity was collected by filtration through a piece of cloth, and on examination by the microscope there could be no doubt that the production was of a vegetable nature and a species of *Rivularia*, associated however with another genus, *Trichormus*, in small quantity. In the first week of July, 1847, the same species were observed similarly associated, but the *Trichormus* was now more plentiful. In July, 1848, it was observed that the *Rivularia* was as rare as the *Trichormus* had been in 1846; to the latter consequently the water of the loch now owed its colour, which was a very dull green.

Other two lochs in the vicinity did not contain the plants alluded to."

Dr. M. C. Cooke says that in July, 1884, this alga (*Rivularia*) was sent to him from a large pond between Haslemere and Farnham, where it rendered the water quite opaque, like a mixture of pea-soup and water.

Lyngbya consists of long rigid or flexuous filaments, bluish-green or yellowish-green in colour, rarely branched. Some species are found in large masses in boggy pools, others in the brackish water.

CLASS II.—ZYGOSPOREÆ.

In this class the plants differ greatly in the structure of their vegetative body, and we are at present acquainted with but few intermediate transitional forms connecting the various sections belonging to it. The formation of a tissue, in the ordinary sense of the term, occurs only in a few cases, the thallus being unicellular; nevertheless, there is a decided advance in the degree of organisation as compared with the PROTOPHYTA.

The *Pandorineæ* consist of cells which are either isolated, or united into families by a gelatinous envelope, and then called cœnobia. In this state they still have the power of motion, each cell possessing two long cilia which protrude through the cell-wall.

Pandorina was the first instance in which conjugation of zoogonidia was observed (Pringsheim), and the process is very curious. Each of the sixteen cells contained in a cœnobium breaks up into sixteen smaller cells, the gelatinous envelopes of which become softened and let the zoogonidia escape. They are green, with a red spot in front, where they bear two cilia, by means of which they move rapidly about. Two of them now coalesce, forming a body at first constricted, then round, and of much larger size than the combined zoogonidia, of which however the four cilia and the two red corpuscles are still seen, but these soon dissappear. The colour of the cell now changes from green to brick-red, and the cell, which has greatly increased in size, breaks up and allows the escape of several large zoospores. The zoospores, after a short period of swarming, surround themselves with a gelatinous envelope, and by successive divisions give rise to sixteen primordial cells, forming a cœnobium similar to the mother plant.

Equally interesting is the life history of *Stephanosphæra*, but our space forbids our dwelling on it: it has been calculated that in eight days, under favourable circumstances, more than sixteen million families might be formed from one resting cell.

Pediastrum has also been included in this class, on account of its general affinities, for the phenomenon of conjugation has not yet been observed in it. When the cœnobia multiply a large number of zoogonidia are formed in each mother cell, within which they move about for some time, ultimately coming to rest, congregated in some definite arrangement, and continuing their development unitedly.

The same uncertainty applies with regard to *Hydrodictyon*, which forms a beautiful object, like a miniature green net, the meshes being very distinct. Dr. Wood, in his "American Fresh Water Algæ," says that this genus grows in great abundance in Philadelphia, in the ditches and stagnant brick-ponds in the low grounds below the city, where it forms floating masses several inches thick, and many feet in extent, of a yellowish-green colour. It is in great profusion in June and July, is hardly to be found in the autumn, but reappears early in the spring.

Mesocarpus and *Zygmena* both consist of cylindrical segmented filaments of a green colour, and in both the phenomenon of conjugation may be well observed, as it may be also in the well-known form *Spirogyra* and its allied genus *Rhynconema*. In *Characium* the zoogonidia, after swarming in the mother cell, escape by a lateral rupture, and move rapidly about with the aid of their cilia: no conjugation has been observed. This form is frequently found attached to other filiform algæ.

Hydrurus is apparently propagated only by means of gonidia; the thallus is elongated, covered with delicate fibres, and of a bright green colour and of gelatinous consistence; the fronds are often found in large clusters.

Class III.—Oosporeæ.

The Thallus may consist of undifferentiated cells, or of a single tubular cell, which often branches freely. In the higher forms the thallus consists of branched and segmented filaments composed of cells of different kinds, and the plant, which is

generally fixed to a substratum, manifests a marked contrast between base and apex.

Sphæroplea is the simplest of the OOSPOREÆ. The filaments consist of very long cells, the contents of which are a colourless protoplasm, a green chlorophyll, a watery liquid and granules of starch, the whole so disposed that the liquid element forms large vacuoles in a row, like the pearls of a necklet engirdling the plant.

On approaching fructification the vacuoles multiply to such an extent as to give the endochrome the appearance of a frothy mass, in which the starch granules are irregularly scattered. Soon after the starch granules assemble in twos, threes, or larger numbers, and around these groups the green plasma becomes more plentiful, so that in time they appear as so many equadistant cysts in the axis of the thread. These green clots assume a stellate appearance, then become flattened to resemble partitions, which by and by disappear, and the whole thread breaks up into a number of free globular masses, which, after various modifications, become the young spores.

All the cellules of the same filament do not undergo the modifications described. In a large number the green rings, interspersed with colourless vacuoles, gradually change to a reddish yellow, and the grains of starch disappear. Soon the coloured matter thus formed becomes granular, and is finally broken up into numerous rod-like corpuscles.

In the sexual reproductive process some cells give rise to antherozoids, others to oospheres; after fecundation the oospore changes from green to red, and becomes enclosed in a stellate covering. The filaments of *Sphæroplea* do not root themselves, both extremities being similar, and vegetation being carried on by sub-division of the central cells, so that the terminal cells remain the oldest.

Vaucheria consists of a single elongated cell, branched in various ways and usually fixed to one spot.

The antheridia are lateral, sessile, or cut off by a septum from the branch bearing them; the genus has been sub-divided, according to the special characters of the antheridia. The oogonia are lateral, sessile, or stalked, and after fertilisation become red or

brown and invested with a thick cell-wall. The sporangium is terminal, and gives rise to one large zoospore, densely clad with vibratile cilia. Probably reproduction also takes place by means of zoogonidia, as Mr. Bates, of Leicester, found some filaments of *Vaucheria* beneath ice in a pool, in which zoogonidia were apparently in the course of formation. Some species of *Vaucheria* are infested by *Cyclops lupula*, which occasions the growth on the filaments of extraordinary looking appendages, in the midst of which the parasites reside.

The *Volvox* family contains two most pleasing and well known genera, *Volvox* and *Eudorina*, the cœnobium of the former containing a great number of cells, and of the latter either 16 or 32. The genus *Eudorina* very much resembles *Pandorina* in appearance; there is, however, a great difference between them physiologically—*Pandorina* being reproduced by conjugation of zoogonidia, as has already been described; *Eudorina* by means of antheridia and oospheres. Non-sexual reproduction is effected in *Volvox* by the repeated division of certain cells—in *Eudorina* by division of any of the cells.

The well-known rotary movement of *Volvox* is produced by the combined action of the numerous pairs of cilia in which the gonidia terminate and which protrude through the cell wall. The rapid appearance or disappearance of large numbers of *Volvox* in the same pool is doubtless due to the fact that a slight change in external conditions suffices, on the one hand, to favour the development of countless thousands of young plants, and, on the other, to destroy the vitality of the colony, or to drive it to seek refuge in deeper water.

The monograph of Mr. Wills on this genus, to be found in the *Midland Naturalist*, for 1880, is a classical one in English botanical literature.

Eudorina is much smaller than *Volvox*, and also possesses the same rotary motion. It also appears and disappears in the same rapid manner as *Volvox*.

The family *Ædogonieæ* contains two genera, *Ædogonium* and *Bulbochæte*, which are fixed at the lower end often to the submerged parts of other plants.

In *Ædogonium* the thallus is unbranched, in *Bulbochæte* it is

branched, and in both cases it consists of rows of cells which multiply by intercalary growth, while the terminal cells elongate into hyaline bristles. The slender filaments of *Ædogonium* resemble those of *Conferva* at first sight, but are distinguished by transverse parallel striæ at one or other extremity of the cells indicating the mode of increase. In *Bulbochæte* the growth proceeds by continuous division of the basal cell, and the cell membrane is usually punctate.

In both genera the asexual reproduction is of the usual character, but the sexual reproduction is varied. In *Ædogonium* the plants may be monœcious, or diœcious, and the diœcious species may be further divided, according as the male filaments are derived from certain privileged cells in the female plant, or are from the first distinct from the female filaments. The *Bulbochæte* are divided into two sections, according to the shape of the oogonia, whether globose or ellipsoid. The first section is diœcious, and is further sub-divided according as the dwarf male plants are unicellular or bicellular. The second section is sub-divided into monœcious and diœcious species.

The *Confervеæ*, like the *Ædognieæ*, consist of rows of cells or segmented filaments, which either remain unbranched as in *Chætomorpha*, or become branched as in *Cladophora*, *Stigeoclonium*, *Draparnaldia*, and *Chætophora.* With reference to their reproduction, it is only known that macro- and micro-zoogonidia are formed in the cells of the filaments (*Chætomorpha*, *Cladophora*), the sexual significance of which is still unknown ; and that in the other above mentioned plants, resting spores are formed in certain cells of the filaments. Pringseim suggests that they are probably equivalent to oospores, but that they are produced parthenogenetically. The *Ulvaceæ* are probably allied to the *Confervеæ.* In them the cells are arranged so as to form a delicate membrane ; whilst in the other genera the cells form slender filaments of a soft membraneous nature. In *Chætomorpha* the long filaments are interwoven either in lax tufts, or in dense strata, each filament being curled, twisted, or bent somewhat irregularly.

In *Cladophora* the filaments are irregularly branched and curled, of a light membranaceous substance, and often forming detached floating tufts. Some species are found in great abun-

dance at the bottom of ponds or lakes, occasionally rising and floating on the surface.

Draparnaldia is recognised by its filaments being furnished more or less densely with penicellate, fasciculate branchlets, alternate or opposite, composed of smaller fertile cells. The terminal cells of all the branches are empty, hyaline, and sterile, and more or less elongated into a bristle.

Class IV.—Carposporeæ.

This class, while possessing many points in common with the class Oosporeæ, is nevertheless characterised by the formation of the spore fruit, or sporocarp, which consists of two distinct parts, viz., a fertile part, derived directly from the female organ, and ultimately producing spores, and an investing part, which encloses the spores until ripe, but which is relatively small and merely appendicular in the fresh-water Algæ, although attaining great prominence in the Fungi.

The *Coleochæteæ* are small discoid algæ of a bright green colour constructed of branched rows of cells, attached to the submerged parts of other plants in the form of little circular masses. The name of the genus is due to the fact of certain cells of the thallus bearing colourless erect bristles.

The reproduction is by a sexual zoogonidia and by resting spores. The resting spores do not at once produce new plants, but zoospores. The zoospores produced early in the year from a sporocarp of the previous year, produce only asexual plants for several generations. At length a sexual generation arises which may be monœcious or diœcious, and fertilisation produces one oospore in the carpogonia, which clothe themselves with a peculiar layer of cortical cells, and the oospore itself developes into a parenchymatous reproductive body, from the cells of which zoospores proceed in the next period of vegetation.

Batrachospermeæ contains the two genera, *Batrachospermum* and *Thorea*. In *Batrachospermum* the thallus is moniliform, composed of a simple series of medullary cells and a cortical accessory parallel series, clothed with sub-globose clustered fascicles of branches.

In *Thorea* the thallus is filamentose, attenuated at the apex

with a solid central medullary stratum, surrounded by dichotomously divided branchlets. The asexual reproductive organs or gonidia are generally formed in fours in a mother cell; hence they are termed Tetragonidia. The sexual reproduction is usually diœcious; the antheridia are single cells at the end of long articulated branches, each producing only one antherozoid; the carpogonium consists of a single cell, which is prolonged upwards into a trichogyne. The roundish antherozoids have no cilia and do not swarm, but are moved along passively by the water; some of them are thus brought into contact with the trichogyne, adhere to it, and in consequence of the absorption of the cell walls at the points of contact, their contents pass into it, the trichogyne remains otherwise permanently closed. After fertilisation the basal portion of the carpogonium becomes multicellular, in consequence of divisions having taken place; the cells thus formed bulge outwards, and give rise to a dense aggregation of short branches, the terminal segments of which are the carpospores. This simple sporocarp acquires a loose investment by the outgrowth of prolongations from the cells beneath the carpogonium. *Lemanea* probably belongs to this class; the thallus is setaceous, almost simple, hollow, nodose, having an internal and a cortical layer of cells, the latter of a brownish or obscure colour. *Lemanea* is said to flourish in rapid currents, contrary to the habits of most algæ—they may be found in mill sluices and in the most impetuous cascades. *Chantransia* and *Bangia* are both doubtful members of this class; the thallus is filamentous, and purple or violet in colour, and tetraspores are found in each genus.

As regards the process of sexual reproduction, it has as yet been observed only in a small proportion of the numerous genera of Algæ; nevertheless, it is permissible to assume that in some of the remaining genera such a process actually takes place, an assumption which is strengthened by a similarity of development in certain instances between the two.

The whole subject is, however, itself in a state of development, and the present scheme will probably require alteration and rearrangement before it can be universally accepted. The presence of the fructification is an important point in determining a given species of Algæ. Cooke says that a great many species described

by authors, even up to the time of Hassall, cannot be definitely placed on account of this deficiency.

Cooke describes over 120 genera of fresh-water Algæ, some of which contain many species—the genus *Ædogonium* possessing over 50 species; other genera containing from 12 to 20 species, and fresh species are frequently being described.

This description includes only British species ; those common to the Continent of Europe generally being much more numerous. Fresh-water Algæ have been found in all parts of the world, those from the tropics being often very luxuriant in their growth; the fresh-water Algæ of America have been fully described and illustrated by Horatio Wood.

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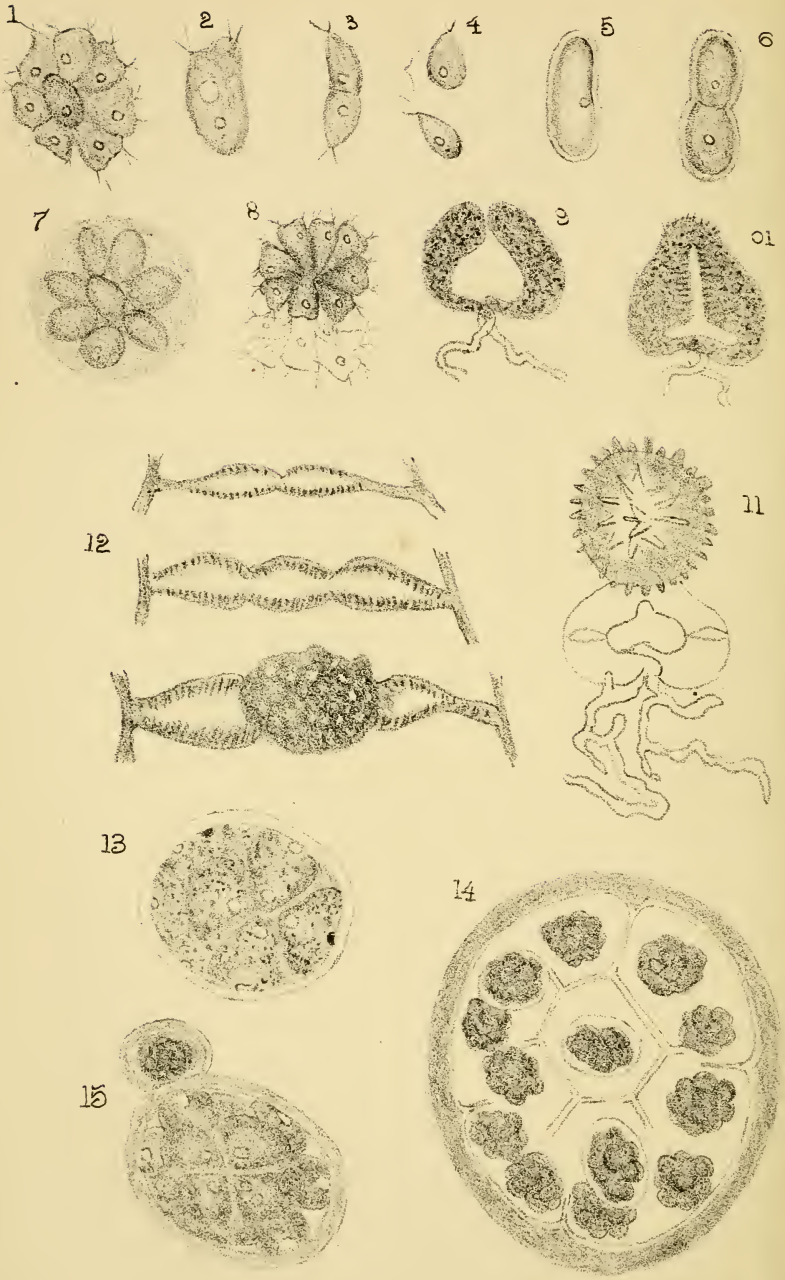
EXPLANATION OF PLATES IX., X., XI.

Plate IX.

Figs. 1-8—Development of *Sorastrum*.
1.—Colony of unicellular individuals.
2.—A separate cell
3.-6.—Formation of new cells.
7.—A new colony.
8.—A double colony of old and new cells.
,, 9-11.—Conjugation and production of zygospore in *Pandorina*.
,, 12.—The same in *Rhizopus*.
,, 13.—Adult form of *Pandorina*.
,, 14-15—Various stages in development into separate plants, containing clusters of zoospores.

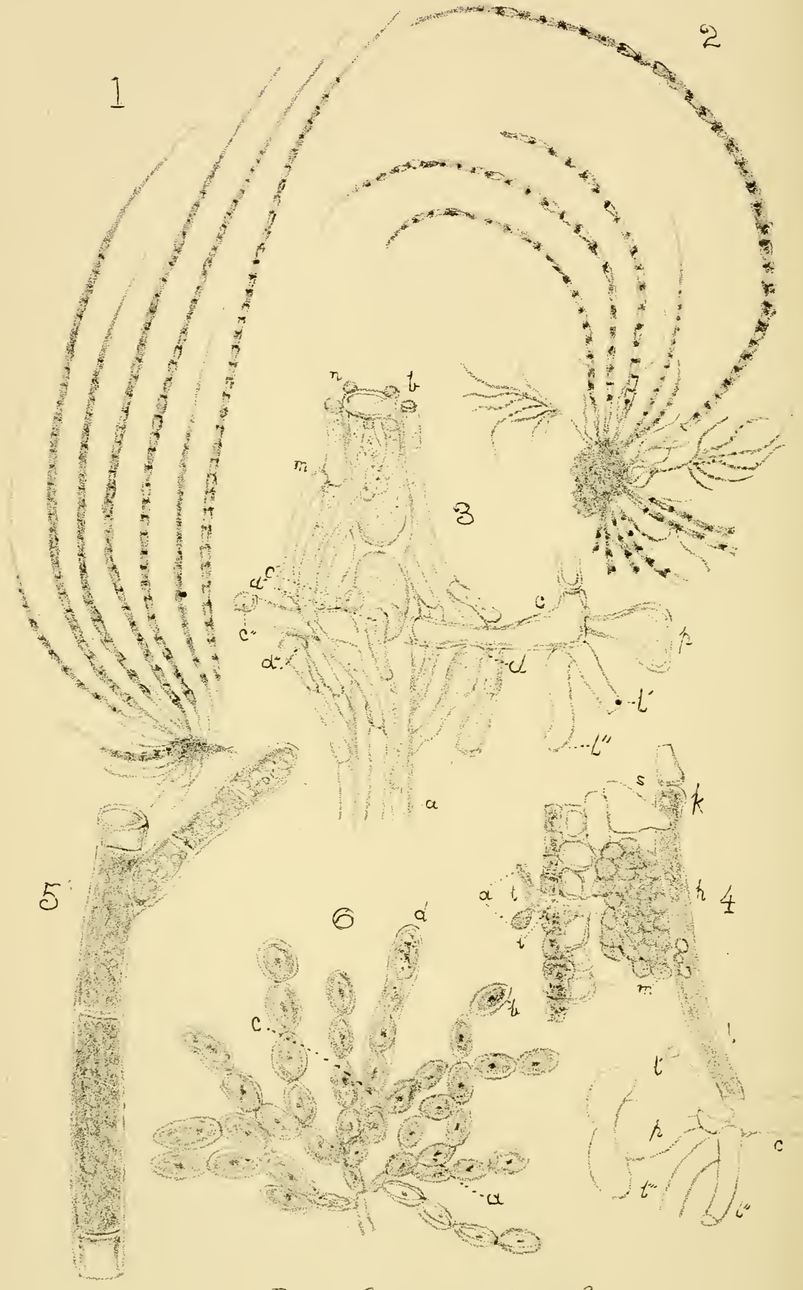
Plate X.

Fig. 1.—Continuation of Figs. 14-15, Pl. 9.



Development of Fresh-water Algae.

Development of
Fresh-water Algae.



Development of Fresh-water Algae.

Fig. 2.—Small plant of *Ædogonium* showing oogonia and antheridia (*b*). The upper one is fecundated ; the lower unfecundated.
,, 3.—A separate unfecundated oogonium.
,, 4.—Entrance of antherozoid into oogonium.
,, 5.—Completion of fecundation.
,, 6.—Free antherozoids.
,, 7.—Oospore
,, 8-9.—Carpogonia and sporocarps of *Podosphæra*.
w.—Female organs before fertilisation.
m.—Male organs and entire sporocarp.
h.—Its envelope, *c.s.*, the spores.

PLATE XI.

Figs. 1-2.—*Lemanea* with fructification and thallus at base.
,, 3-4.—Longitudinal section of fructifying filament. *a.b.*, central axis ; *it.*, trichogyne ; *a.*, antheridia fixed on it ; *m.*, bundle of filaments developing by budding at the base of the trichogyne.
,, 5.—Fragment of thallus much enlarged, showing distribution of endochrome.
,, 6.—Fragment of spore bearing filament much enlarged.

Note on the Microscopical Appearances in the nervous centres, after death from Hydrophobia.

BY W. B. KESTEVEN, M. D., ST. AND., ENFIELD.

PLATE XII.

MICROSCOPICAL investigation of the nervous centres in man, after death from Hydrophobia, have as yet revealed nothing therein as specially characteristic of this malady. I have thought, however, that an additional record of nearly negative results may not be without a relative value in the history of the disease. I have therefore availed myself of the opportunity open to me by the present from a friend of a portion of posterior convolution, from a case of undoubtedly genuine hydrophobia.

My lamented friend, the late Dr. Lockhart Clarke, once placed in my hands, for examination, a spinal cord from a case of hydrophobia, in which only deep red colour was observable by the

naked eye; and, when examined microscopically, nothing beyond intense congestion was discovered. Dr. Clarke himself has placed on record the fact that he had examined the brain and spinal cord from hydrophobic death, without having noticed anything abnormal.

In the present instance, the most obvious appearance is the great abundance of nuclear cells with which every section is crowded (Pl. XII., Figs. 1, 2). This proliferation, or hyperplasia, of nuclei extends to the minute vessels and their coats, and is well seen in strands of the fibres of the nervous structure (Fig. 3). Under a high power, an eighth, leucocytes were to be seen, and had the appearance of passing through their tissue. The vessels were much dilated from distension during life. Colloid bodies are also to be seen sparsely scattered in the neuroglia.

What has here been recorded would seem to be in accordance with previous observations. Dr. Gowers dwells upon the evidence of preceding extreme conjestion, especially about the nuclei of the hypoglossal and pneumogastric nerves in the medulla oblongata. The article in Ziemssen's Cyclopædia describes also congestion as the most uniform, if not the only, pathological condition. Dr. Long Fox, of Bristol, in his exhaustive work on the "Pathological Anatomy of the Nervous Centres," sums up the lesions in hydrophobia as consisting in vascular conjestion, distension, infiltration, and hæmorrhage, with occasionally traces of grey degeneration.

The preceding observations, although not adding any positive information, are not, as already observed, devoid of interest from a negative point of view.

Explanation of Plate XII.

Fig. 1.—Dilated vessels and proliferation of nuclei in the neuroglia of the Brain substance—Spots of Colloid degeneration.

,, 2.—Dilated vessels with Leucocytes, and proliferation of nuclei in the neuroglia.

,, 3.—Proliferation of nuclei, on, and within the vessels, and among the nerve fibres.

Drawn under ⅛ objective by W. B. Kesteven.

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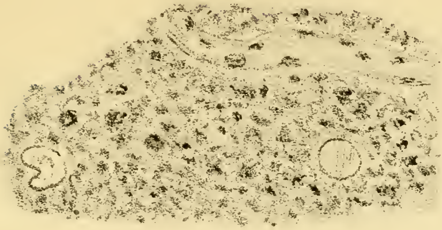

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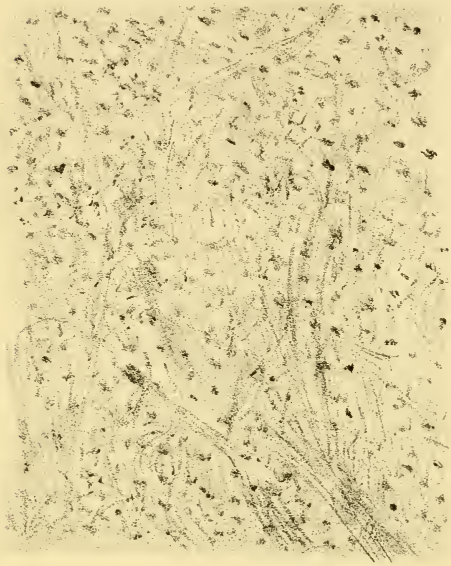

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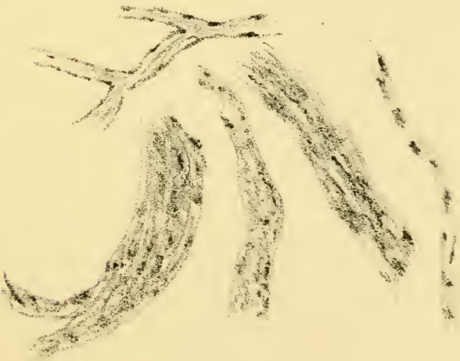

The Brain in Hydrophobia

The Microscope and how to use it.

By V. A. Latham, Late Hon. Sec. U.J.F.C., Norwich.

Part VI.—Double Staining (continued).

Ribesin and Eosin.*—After expressing and throwing away the juice of black currants (*Ribes nigrum*), boil the skins for some hours in a 10 per cent. solution of alum. The resulting deep-violet solution may be conveniently diluted with water, and after a lapse of a day should be filtered, and may be used for staining. The stain resembles Boehmer's Logwood, but is a still more precise nuclear stain. It is a bright, somewhat greenish blue, agreeable, distinct, and permanent. Alcoholic objects stain quicker than chromic acid ones, but the most suitable are bichromate of potash objects. A ribesin stain may be followed by eosin. Brain and spinal cord give good results, especially when hardened in bichromate.

Carmine Staining with Palladium.—When tissues, and especially nerve tissues, have been over-hardened in chromic acid, carmine may entirely fail to stain them. In such a case, the following method (Merkel) is of much service:—Place a large drop of $\frac{1}{4}$ per cent. of watery solution of palladium chloride on a slide, and on another slide a large drop of a strong ammoniacal solution of carmine. Allow the section to remain in the palladium for about two minutes. Wash it in water, and place it in the carmine fluid for about three minutes. Then wash again in water.

To obtain good results with Carmine.—After staining, the superfluous pigment is removed by washing in water acidulated with 1 per cent. hydrochloric or glacial acetic acid, or in rectified spirit 60 parts, water 39 parts, hydrochloric acid 1 part (Pritchard). The acid heightens the colour. Tissues stained with carmine may be mounted in Farrant's solution, glycerine, or dammar.

* See page 41, *ante*.

Process of Colouring Preparations with Picric Acid and Aniline Blue Solution.*—This is very useful, both for normal and pathological specimens. It is well known that certain tissues—as spleen, lymphatics, cerebral, and spinal nervous tissues—retain their colour better and with more elegance when anilin blue is used. Picric acid and anilin blue, mixed together either by subjecting the preparations to be stained to a solution of aniline, and then to another of picric acid. The solutions, whether of picric acid or anilin, ought to be saturated, which can be done easily by leaving an excess of each substance at the bottom of the vessels in which the materials are placed to dissolve. In this way we are always sure of using only saturated solutions. When it is required to make use of the picric anilin solution, 100 cc. (for example) should be taken of the saturated watery solution of picric acid, and into it should be poured 4 or 5 cc. of the blue liquid, also saturated. The resulting solution stains admirably a preparation of the lymphatic glandular system in the space of a few minutes. If it is desired to use the two substances separately, keep the preparation in the anilin solution for a few minutes, and afterwards place it in picric acid. In working thus, we can see that the preparation is not stained *too* much by the analin, and to this end it is well to take it out so soon as it has acquired a light sky-blue tint. By taking it out now, one is always sure that it will show the nuclear elements sufficiently coloured, whilst the protoplasmic parts and others will be only very slightly stained. By waiting until the preparation has taken a dark-blue tint, and then submitting it to picric acid, it becomes obscure and confused. Preparations treated with the anilin solution, as above, and placed in picric acid, pass in the course of 15 minutes from sky-blue to a delicate green. The tissues show the nuclei, both free and cellular, stained green; the protoplasm and the fibres coloured pea-green, though faintly and with a delicate tint. It is possible to stain with great advantage not only fresh tissues, but also those which have been subjected to different hardening re-agents, such as alcohol, chromic acid, bichromate of potash, etc. Preparations obtained by these processes may be preserved like others in fluids or balsam (note, that picric acid, being soluble in water and alcohol, might easily be removed from the preparations upon which it

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has been made to act). To prevent this, it is important that the glycerine used to preserve the preparations should be slightly tinged with picric acid, and if balsam is used, it is necessary to dehydrate the preparations in alcohol, containing also a small quantity of picric acid in solution. In the latter case, after this treatment, the preparations may be at once placed in oil of cloves or turpentine without fear of the stain suffering from it. If it is intended from the first to mount the preparations in balsam, the operation may be abridged by transferring the specimen immediately from the solution of anilin blue to a bath of alcohol to dehydrate it, the alcohol containing $\frac{1}{2}$ per cent. of picric acid in solution. Intestinal injections may also be made with it, and small artificial œdemata may be produced with a Praraz's syringe. In the lymphatic gland the colouring matter can be made to penetrate into the cavernous system, where the endothelial cellules may be recognised lightly coloured green. If a small œdema be produced under the skin of the groin in a rabbit or guinea-pig, the connective cellules and fibres between which they are situated may be studied to perfection by means of eosin, which is soluble in water (Renant). The picric anilin solution may be well employed in interstitial injections, when the picric acid, instead of being dissolved in water, is dissolved in one-third part of alcohol. Preparations thus stained are not affected by the weak acids—acetic, phenic, etc.—whilst alkaline solutions rapidly destroy their beautiful outline. The picric acid solution is especially recommended for the study of the lymphatic glandular system, complete sections of the medulla oblongata, and normal and pathological tissues.

Double Staining with Eosin and various colours (Schieffer-deckar).—The advantage of this method is that it can be applied to preparations hardened either in alcohol or chromic acid. The eosin is used according to Fischer in an alcoholic solution, one per cent. solutions in water are made of dahlia, methyl-violet, and anilin green (alcoholic solutions do not stain enough to be of use, eosin cannot be mixed with the other colours). Stain the section in a small dish containing alcohol, to which a few drops of eosin have been added. Time varies from half an hour to several hours; being left too long in the eosin is not detrimental. The

section is rinsed in water, and loses some eosin; it is then laid in a watch-glass with a solution of one of the other colours and allowed to remain some minutes, till it is coloured very deeply, almost black. Rinse again in water, and then place in alcohol, which dissolves both the colours if not carefully watched. This is in my opinion the most critical part of the process :—*i.e.* hitting the right moment when both the colours have been sufficiently drawn out. A good plan is to take a section out and view it in oil of cloves under the microscope; if found too deep, replace it in alcohol. In general, it is better to remove the preparations when still too blue, as the eosin is drawn out somewhat quicker than the other colours. The oil of cloves, in which the preparations are put after the alcohol, does not affect the eosin, whilst it dissolves the other colours. Any desired relation between the colours can be thus obtained. When stained as required, the oil of cloves is withdrawn as *completely as possible* by blotting paper (the best plan I find is to lay the paper on one side of the preparation on the stage and place it slanting). Then apply Canada balsam in Benzole or Chloroform. If *too much* oil of cloves is left behind, a further extraction of the blue takes place, and the object is surrounded by a blue halo. The skin, nails, hairs, muscular tissue, bones, cartilages, nerve system (though not good for the peripheral nerve system), are finely displayed. Methyl violet, but not the other colours, stains the fine nerves in the skin of the lamprey very beautifully. The alimentary canal, glands aquiparous and muciparous, in the root of the tongue, glands sub-maxillary and sub-lingualis, parotid, pancreas (the lachrimal have most peculiar red cells). The epithelium of mouth, tongue, and œsophagus separate on being stained in the superior and inferior layer; the epithelium, glands of stomach, and intestines are excellently adapted for this staining.

Purpurin :—Take about as much as will lie on the point of a pen-knife, boil in 50 cc. of glycerine, (it may either be concentrated or have a little water added to it), allow to stand for two or three days, and then filter. Unlike Ranvier's solution, it may be kept months without precipitation; it is quite permanent when mounted in Canada balsam and benzole, or glycerine slightly acidulated.

A simple and speedy method of staining Animal and Vegetable sections :—After cutting sections, wash them in water and

allow them to soak for awhile; transfer them to a solution of anilin violet 1 part, dissolved in 300 parts of acetic acid (commercial), leave them till sufficiently stained; which may be determined by removing the solution to clean water. Return if not stained enough. Mount after staining by transferring them to a clean glass slide, drawing off any excess of fluid, and add a drop of a solution of acetate of potash of the following strength:—Acetate of potash, 1 oz; Water, $\frac{1}{2}$ oz. Cover and fasten it with a ring of varnish, if it is desired to preserve it. The advantages are the simplicity and beauty of the results obtained; it is also good for exhibiting the structure of cartilage.

Heidenham's Hæmatoxylin:—A.—$\frac{1}{2}$ to 1 per cent. *aqueous* solution of Hæmatoxylin, and B.—$\frac{1}{2}$ to 1 per cent. solution of Bichromate of Potash. Small pieces of tissue well hardened in alcohol are placed in 8 to 10 c.cm. of A., and after from 8 to 10 hours for a similar length of time, in a nearly equal quantity of B. After they have taken a black colour throughout, the excess of Bichromate of Potash is removed by water. Then dehydrate with alcohol, imbed, etc., cut the sections extremely thin. A blue stain is obtained if, instead of treating the tissue with Bichromate of Potash, a 1 per cent. solution of alum is used. The nuclei are mostly black; the tissue elements more or less of a dark grey or black colour, but so that different elements take an entirely different shade of grey. In epithelial tissue the outlines of cells are extremely sharp, the protoplasm darker, so that a richness of different cells in protoplasm and its distribution in separate cells is well shown. Nerve fibres and markings of primitive bundles are also well shown.

A good stain for Spinal Cord, etc:—A solution of Hæmatoxylin prepared with water and alcohol. The sections are kept immersed in it during an hour, and the temperature is maintained between 40° and 50° C. = 104° to 122° Fahr. They are then removed from the solution, washed and placed for 3 hours in a 2 per cent. alkaline solution (Borax), or in one of potassium ferricyanide. Afterwards they are submitted to the influence of alcohol, xylol, and Canada balsam, in the usual manner.

Corrosive Sublimate for Brain, etc.—After the preparation has been hardened in Müller's fluid, instead of putting it in alcohol, place it for some days in a 5 per cent. solution of corrosive sublimate, which is renewed every day until the solution is no longer coloured. If left *too long* the preparation becomes black, or if *not long enough* small black points appear. It is very elastic and firm, and very thin sections can be cut; it stains very well without ammonia, carmine, etc.

Saure-gelb, Chrysoidin, Rocellin, etc.*—The first colours bone a beautiful orange, tracheal cartilage, and connective tissue, lemon colour, is not suitable for chromic acid preparations. Chrysoidin is useful for bone and all kinds of connective tissue, which it colours a bright yellow. Its best effect is on fresh preparations. Bismark Brown has its best effect with nuclei (either alcoholic or chromic acid preparations), and unicellular organisms, bacteria of all kinds, colourless blood corpuscles, etc.

Rocellin colours bone, muscle, connective tissue, glands, and epithelium cherry-red; gold or orange serves for fresh or alcoholic or chromic acid preparations. Bone is stained deep orange red, cartilage, gold, connective tissue, reddish; especially valuable for glandular tissue; it gives a splendid appearance to liver injected with Berlin blue, the blue vessels showing on a gold ground; sections of skin give fine results. Preparations after washing and cleaning are best mounted in Canada Balsam; oil of cloves is mostly used for cleaning, but where the colours are very delicate, use oil of Lavender or quite colourless oil of Aniseed, as the yellow colour of the oil of cloves injures them.

Staining with Rose Bengale, Iodine Green and Bleu de Lyon.—If dissolved in water it is very useful for staining Chromic Acid preparations—*e.g.*—Spinal Cord, the grey substance of which is stained a deep red, while the white substance is paler. It is also adapted for muscles and connective tissue of Vertebrata and Invertebrata, but not satisfactory for glandular tissue or bones. It is especially suited for double and treble stainings, in conjunction with Iodine green, and Iodine green and an aqueous solution of

* Mikr. Anat., xxii. (1883), p.p. 132-142.

Bleu de Lyon; the nuclei of the gland-cells or the organ of Bojanus, hardened in alcohol, come out emerald green, the protoplasm is unstained; cell membranes and cilia are stained red. A transverse section of the edge of the foot of *Anodonta* from an alcohol specimen should be washed in distilled water, drawn quickly through a dark solution of Rose Bengale, then washed in pure distilled water, and placed for some seconds in Iodine Green, washed again in distilled water, and placed for about five minutes in absolute alcohol to fix the colour and remove possible excess; the sections are now drawn two or three times through a solution of Bleu de Lyon with two parts of absolute alcohol, and three of distilled water, transferred to absolute alcohol, clarified in oil of aniseed and mounted in dammar. The result will well repay all the trouble of preparing.

Stains for Fresh Tissues of Vertebrata:—For fresh or recently dead tissue and thin parts capable of ready examination by transmitted light. The stain recommended is Mayer's Violet Blue of Bindschedler and Busch (Bâle), in about the proportions of one gramme to 300 c.c. of $\frac{1}{2}$ per cent. solution of salt. The mesentery is very well stained by this reagent, the vascular system being very clearly brought out, while the connective tissue is rendered pale red; this is best seen in one of the tâches laitenses of Ranvier. The piece should be first shaken up in a test-tube with some of the $\frac{1}{2}$ per cent. salt solution, then spread out smooth on a glass plate with a brush covered with a drop of staining fluid for ten to thirty seconds, then removed with a bristle and washed with salt solution for examination. The method is preferable to injection, from the distinctness with which the vessels are brought out, the definition of the structure of their walls, the superior rapidity and simplicity, and the prevention of misleading appearances. Specimens too deeply stained can be made paler by washing in a $\frac{1}{2}$ per cent. salt solution; specimens which are quite fresh require a rather lengthy staining, viz., from half to one minute. Another very good object to which to apply this method is the hyaloid membrane of the frog's eye. It is also especially useful for exhibiting smooth muscular fibres, as found in the serous membranes of the pelvis, abdomen, and thorax.

Death of
Mr. J. B. Jeaffreson, M.R.C.S., L.S.A.

OUR Journal has sustained a great loss by the somewhat sudden death, on January 12th, of the above gentleman. For some time he had been one of our principal contributors, *Recent Researches among the Bacteria*, and *The Microscope in Medicine*, being both from his pen.

He was President of the Highbury Microscopical and Scientific Society during 1884, and his Presidential Address on *Animal Metamorphosis* appeared during last year in our pages. He was an accomplished microscopist and an earnest student of natural history, and as such was ever foremost in the work of that Society, whose loss is in more ways than one irreparable. His kindly criticism, his never-failing courtesy, his ready help to all members and on all occasions, his wise judgment, his suggestive counsel—to say nothing of his genial presence and almost boyish enjoyment of the country excursions of the Society—will ever remain a cherished memory in the hearts of all who associated with him.

For twenty-six years he had moved among a large circle of patients in Highbury and Canonbury; the skilled physician, the true English gentleman, and—as many bear testimony—the warm personal friend in their homes.

To me personally he was a true friend, and many are my pleasant memories of his visits, usually bringing a newly-mounted slide, a fungus of which he wished to define the limits, a puzzling water-crustacean, or some specimen, animal or vegetable, that was engrossing his attention, and over which he wished to talk.

If I were asked to name the quality for which I most respected him, I should unhesitatingly say his conspicuous and unwavering regard for all that was noble, righteous, and good in human nature, coupled with an inflexible justice in all his dealings with men and things.

At the early age of 48 he has been called away. He is not *dead!* All that was good and true has only gone where it is still nobler and loftier. We may most fitly write as his epitaph the one word *Emigravit*—he has gone away!

H. W. S. WORSLEY-BENISON.

Half-an-Hour at the Microscope
With Mr. Tuffen West, F.L.S., F.R.M.S., etc.

Catenicella ventricosa (Pl. XIII., Figs. 1—2).—*Catenicella* is the name of a genus of Polyzoa. The general structure of the animals forming these elegant habitations was given in connection with *Flustra foliacea* (see Vol. I., p. 147). Two other forms have been exhibited: the first, *Gemellaria loriculata* (Vol. I., p. 187), the second *Lepralia unicornis*, an excellent specimen, but wanting ovicells. By the kindness of Professor Buck, who takes much interest in our Society, I have had opportunities of carefully examining all the species which are known to him. They are twenty-seven in number; all inhabit the southern portion of our globe, as New Zealand, Australia, Tasmania, Bass's Straits, etc. There is a strong family likeness amongst them; all have a graceful and elegant appearance, and many are curiously sculptured. They are divided into two sections, according to the position and character of the ovicells. In the first section these are subglobose and terminal; of this the example before us may be taken as a type. The other section has the ovicells galeriform (*galea*, a helmet), and placed below and in front of the opening of a cell. The structure of the *Catenicellidæ* shows an interesting adaptation to resistance amongst stormy seas; the calcareous cells being strung, so to say, on flexible, horny branches, like delicate beads on a tough string, whereby they are able to bend freely to, instead of being broken up by, the waters. The animals were unknown when Mr. Buck wrote; perhaps some of our readers may have friends or relatives in southern parts who would be glad to assist science by forwarding specimens with the animals in spirits. I should much like to know the history of this specimen; those in the British Museum collection came from New Zealand and Australia.

May I take this opportunity of pointing out how greatly attention to the derivation of words helps towards their correct remembrance, besides adding interest to our studies by the images they are thus rendered capable of picturing forth? *Catena*, a chain—*Catenicella*, a little chain—is charmingly descriptive, and brings to mind at once the most striking feature in the genus. Then again, *Ventricosus*, like a sail bellied out by the wind, in allusion to the gracefully curved outlines of the cells. I notice that, through an inadvertence in naming the specimen, four of our members have stumbled over this latter word, beginning it with a *d*, whereby it becomes pointless and unmeaning.

Acari from Linnet's Nest (Pl. XIV., Figs. 1—5) are probably examples of *Dermanyssus avium*, an acarine parasite found in the cages of tame singing birds, of which I have for long been in quest of living specimens. Some time ago I purchased a slide of "*Bird-mites*," which shall be sent round for comparison whilst the memory of the present one is still fresh. The mandibles of mine are chelate; whether they are so here I cannot feel quite sure. Chloride of calcium is the preferable medium for mounting Acari, so that the minute details of structure may be precisely made out. The mandibles of the male *D. avium* are said to have "a long external claw"; those of the female to be ensiform. They appear to be truly sword-like in a larger species, *D. gallinæ*, not uncommon in poultry houses, and which I have had the opportunity of dissecting.

Eggs of Lace Wing Fly (Pl. XIII., Figs. 3—8).—This slide shows close observation of nature, and careful endeavour to preserve phases in a curious and instructive life-history. These qualities I trust to see more and more of with our members. It is not by purchased slides, ready prepared, that insight is best gained into the ever-fresh wonders and beauties of Nature, but by carefully observing and truthfully recording what we see. The specimens tell this tale so well that it will be unnecessary here to dilate upon it.

Dr. M—— has asked, "How is the stalk formed?" We learn from "Lowne on the Blow-fly" that in that insect there is, at the anterior extremity of the common oviduct, a pouch. Into this pouch the orifices of the albumen glands and of the receptacle seminis open, and that it appears probable that as the eggs pass through this pouch they are fertilised, and immediately covered with a sort of varnish secreted by the albumen glands. (For diagrammatic sketch see Pl. XIII., Fig. 7.)

Now, if we suppose the eggs in the "Lace Wing Fly" to be covered with a somewhat larger quantity of albuminous material, that shall be rather longer before it finally dries, we shall have the required conditions, as in *a*, *b*, *c*, *d*, Fig. 8 (same plate), where *a* may be taken to represent the egg at its first protrusion, coated with a viscid fluid, indicated by the dotted line; *b*, *c*, the same, still in the grasp of the ovipositor, but adhering to the object on which it has been deposited, and so being drawn out. At *d*, the thread having attained its full length, the parent insect has left it to repeat the operation. I should expect to find an account in either Swammerdam's "*Biblia Naturæ*," or in the works of Réaumer or De Geer. The subject is deserving of investigation in the light that may be thrown on it by our modern microscopists.

Gizzard of Small Foreign Cockroach (Pl. XV., Figs. 1—2).—This is so interesting a specimen that one would wish to see other examples in which the relations of the parts have been less distorted, as also to ascertain the correct name and habitat of the insect whence it has been taken. The number *six* is so usual in the division of insect gizzards that I am led to ask if it be not possible that in so delicate a dissection one of the segments may have disappeared? I should, in making such a preparation, be content with carefully cutting down one side, laying the parts open gently, washing, and then putting up in glycerine jelly. From the appearance of the parts here, I can hardly be wrong in believing it to have been submitted to the action of potash, and in that way seriously injured. It is not unusual to find in a family of insects some species having carnivorous habits, although the majority of the species composing it are phytophagous. Now, in the nature of their food, the Blattæ are known to be mostly *omnivorous*, and I imagine, looking at the specimen before us, that its possessor was of insectivorous habits, and that soft larvæ most likely formed its prey. The gizzards of insects form, when systematically examined, a most interesting study. [Interesting notes on the "Gizzard of Beetle" will be found in Vol. IV., p. 256.—Ed.]

Green Flies.—These beautiful flies are examples of one of the *Chalcididæ*, parasites on one of the Gall-insects. Some of these occasionally appear on our windows in great numbers in the autumn. They are not, properly speaking, "Ichneumon-flies." There is an ovipositor in the females, but it is short, and concealed in its sheath; the minuter parts are scarcely displayed in a way to render identification safe. The gorgeous colours seen on the wings are (like the prismatic hues of a soap-bubble) a purely optical effect of their extreme thinness; to this display of colour the term "iridiscence" (*iris*, the rainbow) is applied. There are no scales on the wings of any of the Hymenoptera. The minute hooks which unite the two wings in flight are well shown in one or two examples, and recall in their simplicity the very similar arrangement present in the wings of Aphides. They contrast well with the numerous powerful hooks on the posterior pair of wings in *Bombus terrestris*.

TUFFEN WEST.

Selected Notes from the Society's Note-Books.

Sting of Wasp.—My idea of a well-mounted Wasp's Sting is this:—1st.—It should be in a natural position. 2nd.—It should show the poison bag and duct. 3rd.—The barbs must be extracted from the sheath. 4th.—It must be transparent enough to see the chitinous parts well, but yet not by any means so transparent as such slides are usually mounted.

H. M. J. Underhill.

Iridiscence of Fly's Wings.—I do not think Mr. Tuffen West's explanation of extreme thinness more than half accounts for the iridiscence of the wings of a fly. The colour is certainly not due to scales, as suggested by another member. Anyone who has blown soap-bubbles will remember that their iridiscence only appears in all its splendour when they are *extremely thin;* when first blown, and when the film is (comparatively) *thick*, the iridiscence is *slight*. Now, these wings are thicker than the film of a soap-bubble; consequently they *ought* not to be iridiscent. I have seen it stated, and from my own observation I believe that the statement is correct, that insects' wings are composed of *two* membranes. These may sometimes be partially separated, and when a wing is *stained* the staining fluid will get between the two membranes. Now, the fact that these two membranes touch one another is sufficient to produce iridiscence, just as "Newton's rings" are formed by two pieces of glass when they touch. That the colours are in more or less regular waves confirms this explanation.

H. M. J. Underhill.

Dermanyssus (Pl. XIV., Figs. 7—9).—Can anyone suggest what is the use of the most extraordinary second pair of legs? Are they for sexual purposes, and analogous to the palpi of spiders? In the ♀ specimen on the slide can be seen what I fancy are the reproductive organs. The structure of the mouth is well worth careful examination, and is best seen in the ♀ specimen, and also well shown in the drawing. The mouth is composed of a lower lip, which I hardly know whether to call labium or mentum. Just within this is a curious triangular membrane, which is very difficult to see. Inside the mouth are two mandibles or chelæ, with one moveable joint at the end, so as to form a pincer. This

is minutely serrated on the inner side, and is opposed to another claw, which is immovable. Fig. 8 in Pl. XIV. shows one chela inside the mouth and one protruded. In Fig. 7 the basal joints only are drawn, so as to avoid confusion. It will be noticed that the palpi have each a small tuft of hairs at the tip. The spiracle is curious. In the specimen on the slide the muscles can be seen. Their chief centre seems to be in the ventral plate. My *Dermanyssi* were not parasites, but were found during the month of February amongst moss on the top of a wall.

H. M. J. UNDERHILL.

Fish Parasites (Pl. XV., Figs. 3—5).—*Caligus Rapax* is common on salmon when they first come into season, and may be picked off the fish as they lie on the salesman's counter. I extract the following from Baird's "Student's Natural History"; it may, perhaps, prove interesting:—

"The animals of the genus *Caligus*, as established by Müller, though all agree in living as parasites upon fishes and other aquatic animals, and having the organs of their mouth adapted for suction instead of mastication, present so many differences among themselves that it has become necessary to separate them into various genera, and even into several families. In all, the mouth is provided with an apparatus by means of which the little creatures can puncture the skin of their hosts, and suck up the nourishment derived from their bodies. They attach themselves to the fishes on which they are found by a set of sharp-pointed hooked claws, called foot-jaws. In general they are not immovably fixed there, many of the species being able to move from one part of the body to another. The eggs in the female are numerous, and are generally contained in long slender ovaries, which depend in a straight line from the abdomen. When hatched, the young are very unlike their parent, and, like those of the *Cyclopidæ*, which they resemble considerably in appearance, they undergo a series of changes in their progress to maturity. They are at first free and unattached, swimming freely in the water, and do not acquire their parasitic habits till after several moultings and changes of skin. Many species have their head in the form of a broad flat buckler, while the thoracic and abdominal segments are uncovered. These form the restricted family of *Caligidæ*, with the genus *Caligus* as the type, the species of which live on marine fishes, though in the case of the salmon they are capable of living for some time in fresh water also. Other species have a series of lamellar plates, like the elytra, or wing cases of beetles, extending along the dorsal surface of the body. These form the family *Pandaridæ*, with the genus *Pandarus* as its type, when these plates

are two or more in number, and the family *Cecropidæ*, with the genus *Cecrops* as the type, when only one plate exists. They are all parasitic upon marine fishes, and the fishermen commonly call them *fish-lice*."

H. E. Freeman.

Caligus.—I am rather surprised that although several members have well described the *Caligus*, or "fish-louse," no one has explained, for the benefit of the unlearned, that it is really a *Crustacean*, not an insect like the louse, nor an arachnidan like the mites.

H. F. Parsons.

Cidaris (spines of).—This slide introduces us to one of the last surviving members of a once numerous family. The genus *Cidaris* was very abundant in oolitic and cretaceous times, but few living representatives now remain. Cidaris and its allies differ from Echinus in the mode of articulation of the spines to the tubercles. In addition to the capsular ligament there is a central ligament, which is inserted into a little pit on the summit of the tubercle, like the "*ligamentum teres*" of the hip joint; this, however, is not shown in the specimen before us. *Pedicellaria* with long stalks may be seen among the spines. The spines of the fossil species are very like the present specimen, but larger, some six inches in length.

H. F. Parsons.

Santonine.—A neutral crystalline substance, obtained from a species of *Artemisia*, allied to the Wormwood. It is not an alkaloid, like quinine and morphia, for it contains no nitrogen, its formula being C_{15}, H_{18}, O_3. This slide has, I believe, been prepared by fusion. I have got a similar appearance by spreading a thin layer of melted santonine on a slide and touching it in a number of places as it cooled. When deposited from hot spirits santonine crystallises in prisms, most of which appear of a steel blue by polarised light.

H. F. Parsons.

Santonine is most easily prepared as a polariscope object by dissolving it in chloroform and then evaporating a few drops on a glass slide. If the slide is *previously* heated, and the solution be dropped upon it, floriated and radiated crystals are obtained, and the forms vary according to the amount of heat to which the slide has been subjected. Fusing santonine does not answer, as most of the substance evaporates. C. F. Tootal.

Dermanyssus.—These appear to be very nearly alike from all kinds of birds, except that from the tom-tit, which is a most extraordinary creature, having the second pair of legs turned back, and reaching a long way beyond the whole length of the mite.

J. BEAULAH.

Dermanyssus, to avoid the curling up of the legs in mounting. —When the animal can be got alive I have avoided this "curling" by allowing it to walk on the slide; then drop tolerably cool glycerine jelly on to it, and whilst it is trying to grasp the situation, with *all its limbs extended*, drop the warm cover on, and on examining when cool the object will be found to be well displayed, colour natural, and no air bubbles.

J. C. THOMPSON.

Bird Parasites, to mount.—My usual plan is to catch them alive, if possible (with a needle dipped in turpentine), and immediately put them into a bottle of turps. When they have been soaking a few hours for the small ones, and longer for the larger ones, lift them out with a tube, and deposit a drop of turps on the slide with two or three parasites in it. Arrange with a needle, and then, taking a small quantity of balsam on a needle, touch the slide near the objects, draw a thread of balsam across and round about them, then put aside for the turps to evaporate. Afterwards a drop more balsam and a cover will settle that slide. By adopting this method I have seldom had any trouble with the smaller kind of parasites.

H. R. BOULT.

Santonine.—I subjoin my process for preparing this slide. Having dissolved from three to six grains of santonine in a drachm of chloroform, I place a slide on the turn-table, and take a small drop of the solution in a pipette, and, giving the wheel a rapid motion, cover a sufficient space, and with a point make a ring round it. I then remove, and subject it to such a degree of heat as experience dictates, until crystallisation is completed. The slide is now ready for mounting *dry*. *Balsam is destructive.* In order to view it effectively, I place the analysing prism in a *known* position, and then turn the polariser until it gives the selenite a salmon colour, which produces the most brilliant results. A very small move of the analyser reduces the effect.

A. NICHOLSON.

Spicules of Spongilla Fluviatillis (Pl. XVI., Fig. 1).—I have had under observation a living specimen of this sponge for the last ten weeks, during which time it has grown, producing new sarcode, in which also is rapidly forming new spicules, the form of which is shown in plate, being bulged out in the middle. The mature spicules are smooth and even, and pointed at the ends, and slightly curved.

JAS. FULLAGAR.

Foot of Fly (Pl. XVI., Figs. 2—3).—In the foot of this fly, which is very commonly found in corners of walls, etc., the pads are unusually delicate and beautiful, the central one being prolongated almost like a riband. I think there are not any suctorial terminations to the hairs, that being entirely unnecessary, owing to the flexibility of the pads themselves.

E. TUTTE.

Caligus (Pl. XV., Fig. 3).—I wish to point out that the name *fish-louse*, by which this animal is popularly known amongst fishermen, is not actually correct, though quite near enough in its accuracy of definition to suit the purpose. It is a crustacean, parasitic on many of our salt-water fish, and is itself subject to the attack of a parasite, which lives upon or just under the edge of its carapace. My observations of its life-history lead me to think that its presence is not a certain indication (as has been asserted) of disease in the fish upon which it is found ; for taking one large family—the cod—it is rare to meet with one on which no single specimen of this parasite can be seen. Yet it is ever found in greater abundance on weakly and wasted individuals than on the more robust and healthy members of the shoal. I remember two years ago examining closely one morning over a hundred large cod caught that morning at Newfoundland (a fishing ground just off the North Foreland), among which was one poor, flabby, wasted fish, whose right eye had by some accident been torn out, and was lying three parts out of its socket upon his cheek. The injury was evidently of long standing, and the fish was poor and out of condition, and overrun with the Caligus. I took over forty of these parasites off it, and it was one of these which, after being mounted by Mr. Topping, I sent round. The figure in Baird's Entomostraca (Ray), so faithfully copied in our Note Book, shows (at *h)* a second pair of jaws. These, however, I have been unable to make out clearly in my own mounts or in the vastly better mounts of Mr. Topping.

W. LANE SEAR.

Caligus.—The family Caligidæ contains four British genera:—

1.—*Caligus.* Fourth pair of feet slender, of only one branch, and used for walking. A pair of small sucking discs on the lower surface of the frontal plates.

2—*Lepeoptheirus.* Fourth pair of feet as in Caligus. Frontal plates destitute of the sucking plates.

3.—*Chalimus.* Feet as above. Frontal plate provided with a long and slender prehensile appendage, arising from centre of its anterior surface; and

4.—*Trebius.* Fourth pair of feet slender, and divided into two branches, adapted for swimming. No sucking discs on frontal plate.

Caligus is divided into *(a)* C. Diaphanus, *(b)* C. Rapax, *(c)* C. Mülleri, *(d)* C. Centrodonti.

The *lunules* are sucking discs by which the Caligi attach themselves to the fish.

The mouth consists of a siphon, composed of two long slender styliform organs, armed on their points with about twelve feet.

The three pairs of foot jaws are used to fasten themselves to their prey.

The Caligi are only found on marine fishes. They can move about on the fish and swim. Their food is doubtful. Some say that they drink the blood of the fish. More probably by moving their branchial feet they carry to their mouth the molecules from the water and molecules from the fish.

They change their skin. The young, when first hatched, differ greatly from the adult (see Figs. 4 and 5).

H. W. Elphinstone.

Fresh Water Larvæ, sent by Mr. Vial, was mounted without pressure and without the use of potash. It was simply placed on blotting-paper to drain, then soaked in oil of cloves for a month, and mounted in balsam.

Weevils.—It is said there are 10,000 specimens of *Curculis*, of which 400 are British. They are very destructive to plants and fruit. *Balaninus mneum* attacks nuts, boring the shell, for which purpose its mouth is adapted, and depositing its eggs, which in due course produce the larvæ, who, after feeding on the nut, at maturity bore their way out.

H. E. Freeman.

Coccus from Malta Orange.—On this slide will be found the shell or case under which the creature lives, and in which it may

be imperfectly seen, eggs in various states of development, and the creature itself separate from its dwelling; also some broken and damaged specimens, which, notwithstanding, have interest. The mouth structure will well repay examination.

It will be seen that the creature has no legs, and its motion when living is vermicular.

W. CASE.

Anguillula tritici.—This slide contains two males and one female near them; the latter is an eel of the usual adult size. It is well known that the black grain called "burnt corn" is a mass of torpid eels, which become active in moist ground; such of them as come into contact with a fibre of wheat root enter it, and pass up the straw into the ear, and luxuriate on the nutriment it finds there. In the meantime, having grown to an enormous size, the female discharges her hundreds of eggs and dies. The young eels leave the egg their full size, and live on the nutriment as long as it lasts; they then become torpid, and remain so until revivified in the way of their parents. Some curved processes will be seen near the end of the tail of the male eel, which I have reason to believe are for clasping purposes. Further particulars may be seen in *Science Gossip*, March, 1877.

A. NICHOLSON.

Trichina spiralis encysted in Human Muscle.—This Entozoon is introduced into the human intestine in the larval form by eating measly pork (uncooked German sausage being a fruitful source), and rapidly arrives at maturity. The young filaria, travelling through all surrounding tissues, shortly after their birth, make their way straight to the voluntary muscles, where they usually become encysted. Some of these cysts are calcified, and so hide the worm. One cyst on this slide shows two worms in it. Boiling the meat well is the best way to destroy these Entozoa.

T. W. REID.

Larvæ of Vapourer Moth.—These insects are placed by Westwood among the *Arctridæ*, the same family to which the Tiger Moths belong, whose hairy larvæ are known by the name of "Woolly Bears." He says :—

"Other larvæ, especially those of Orgyia, are furnished, in addition to the long slender hairs all over the body, with several short, thick, truncated tufts of hair on the back as well as at the side, with several other longer and more slender tufts of hair, each

hair being thickened at the tip. Of these tufted larvæ the majority produce species not materially differing in the sexes; but some, forming the species Orgyia, have females with the smallest rudiments of wings, and large swollen abdomens, and which are exceedingly sluggish in their habits, whilst the males are constantly on the wing, flitting about in the hottest weather of autumn; thence, probably, called Vapourer Moths."

A. HAMMOND.

"Coralline."—I am sorry to see that some of our members use the term "Coralline," as applied to Polyzoa or Bryozoa. It was a term formerly used to include organisms both of animal and vegetable structure, as may be seen in Ellis's standard work on the subject, which represented what was known on the subject in 1755. As the term Coralline is now strictly applied to a genus of Algæ which is entirely vegetable, and is characterised by a deposit of carbonate of lime in its structure, it is not correct to speak of one of the Polyzoa as "Coralline." A familiar English term for it is Zoophyte, but that even is not a good term, as what are called Zoophytes include families belonging to two widely separated divisions of the animal kingdom, viz., the Hydrozoa, or Hydroid Zoophytes, which belong to the *Radiata*, a division of the animal kingdom, and the Polyzoa or Bryozoa, which is a division of the Mollusca, and is much higher in the scale of organisation.

G. D. BROWN.

EXPLANATION OF PLATES XIII., XIV., XV., XVI.

PLATE XIII.

Upper Portion.

Fig. 1.—Represents a specimen of *Catenicella ventricosa*, natural size.

,, 2.—A portion magnified 25 diameters, and showing:—*c.c.*, ordinary cells; *m.*, mouth, whence the inhabitant issues; *st.*, horny connecting stalk; *b.h.p.*, "avicularum," or bird's head process; *ovc.*, ovicell.

Lower Portion.

Eggs and Larva of Lace-Wing Fly.

,, 3.—Larva just issuing from the egg.

,, 4.— ,, ,, ,, somewhat further advanced.

,, 5.—From another specimen of the same series, in which the young creature is fully liberated and about to capture prey.

,, 6.—Lower portion of one of the stalks, to show the expanded base of adhesion and the wrinkling to admit of flexion.

Fig. 7.—Diagram explaining how the eggs are fertilised and coated with glutinous matter in the parent insect. *ovd.*, *ovd.*, two of the oviducts ; *p.*, pouch ; *c.o.*, common oviduct ; *a.g.*, *a.g.*, albumen glands ; *r.s.*, *r.s.*, receptacula seminis of the Blow-Fly.

,, 8.—Diagrammatic representations of the method in which the long stalk is produced, numbered *a* to *d*. (See Mr. Tuffen West's notes, page 114.)

Drawn by Tuffen West.

Plate XIV.

Fig. 1.—Acarus from Linnet *(Dermanyssus avium)*. *d.s.*, dorsal shield ; *a.s.*, abdominal shield ; *sp.*, spiracles. × 50 diam.

,, 2.—Oral organs, × 100 diam. ; *m.d.*, *m.d.*, mandibles ; *pp.*, palpi.

,, 3.—Portion of a specimen in the possession of the writer, supposed to be a male of the same species. *sp.*, spiracle.

,, 4.—Foot from second limb of right side, × 200 diam.

,, 5.—Oral organs from a male of *Dermanyssus avium*, taken from the figure in the Micrographic Dictionary, and put into diagrammatic form for the sake of clearness.

,, 7.—Male *Dermanyssus*, × 33 diam., showing remarkable development of second feet. *m.*, mentum and labium ; *p.*, palpi ; *ch.*, basal part of chelæ (see Fig. 8) ; *sp.*, spiracle ; *v.*, vent.

,, 8.—Mouth organs, × 51 diam. ; *m.*, labium and mentum ; *p.*, palpi ; *ch′*, chela when at rest, as shown in Fig. 7 ; *ch″*, chela thrust out and open as for eating.

,, 9.—Side view of foot, × 166 diam. A front view of the same is much like Mr. West's drawing, Fig. 4, above.

Figs. 1 to 5 drawn by Tuffen West.
,, 7 to 9 ,, H. M. J. Underhill.

Plate XV.

Upper Part.

Fig. 1.—Represents the different parts of Gizzard of small foreign Cockroach, as shown on slide, × 25 diam.

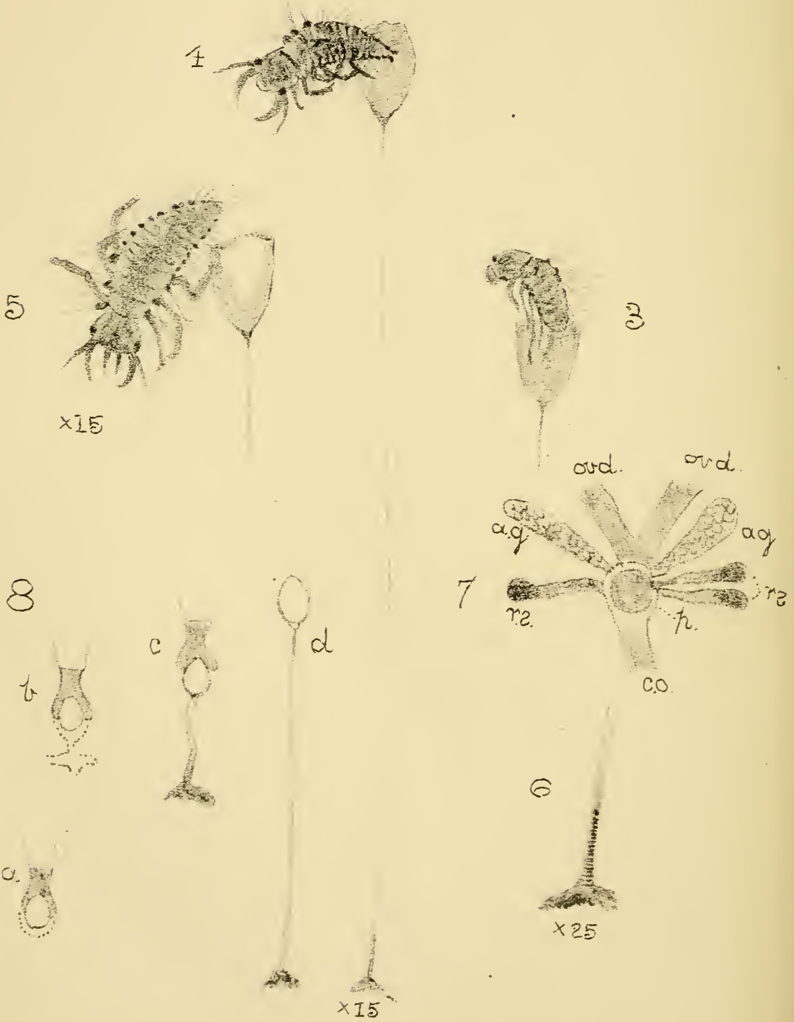
,, 2.—One of the teeth and punctate lateral plates, enlarged to 100 diam.

Drawn by Tuffen West.

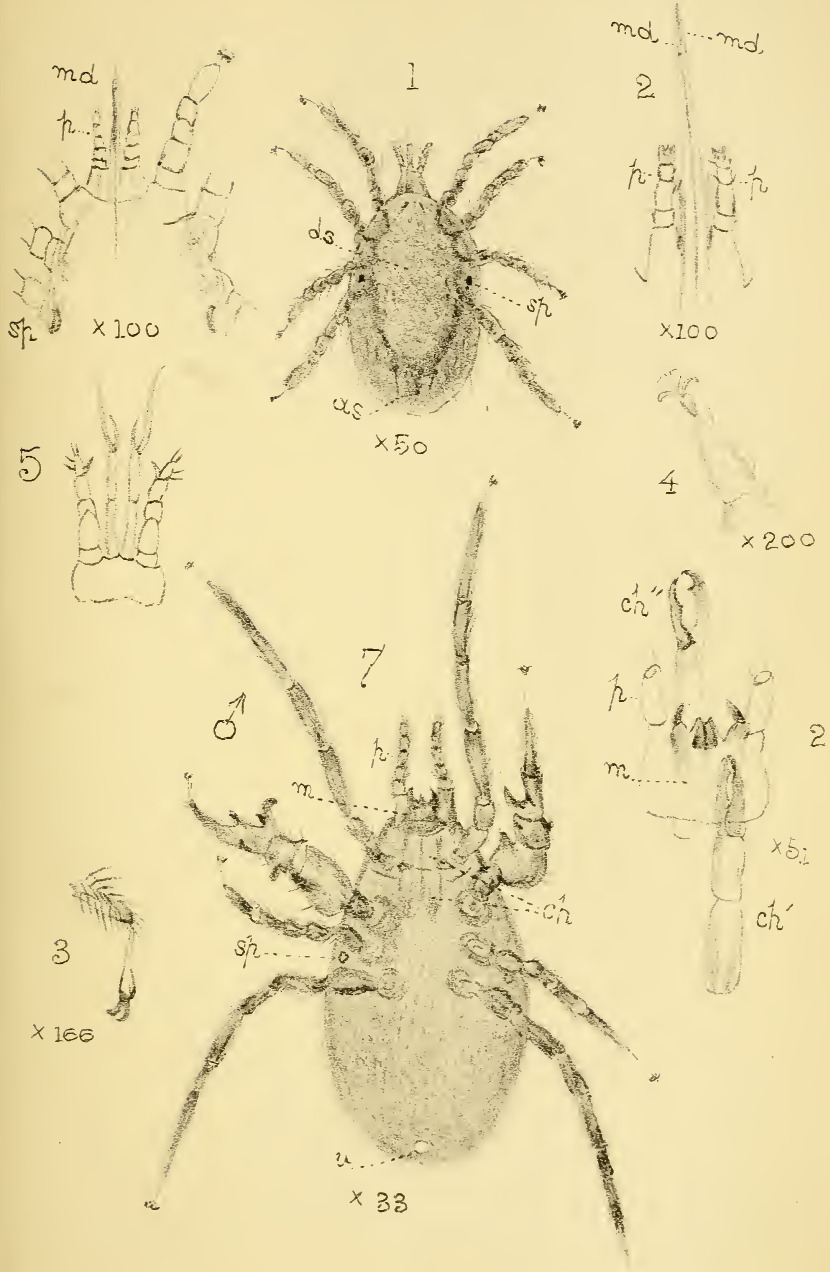
Lower Portion.

,, 3.—*Caligus diaphanus*, from "Baird's British Entomostraca." *a*, lunules, or sucking discs ; *b*, antennæ ; *c*, first pair of foot-jaws ; *d*, rudimentary appendages ; *e*, analogues of the two pairs of jaws in other orders of Crustacea ; *f*, mouth ; *g*, organs representing the posterior pair of jaws ; *h*, second pair of foot-jaws ; *i*, third pair of foot-jaws ; *j*, sternal fork ; *k*, first pair of thoracic feet ; *l*, second pair of ditto ; *m*, third pair of feet ; *n*, fourth pair of feet.

Catenicella ventricosa.



Eggs &c. of Lace-Wing Fly.


md
p
sp
×100
1
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×50
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md
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×100
4
×200
5
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×166
7
♂
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u
×33
ch''
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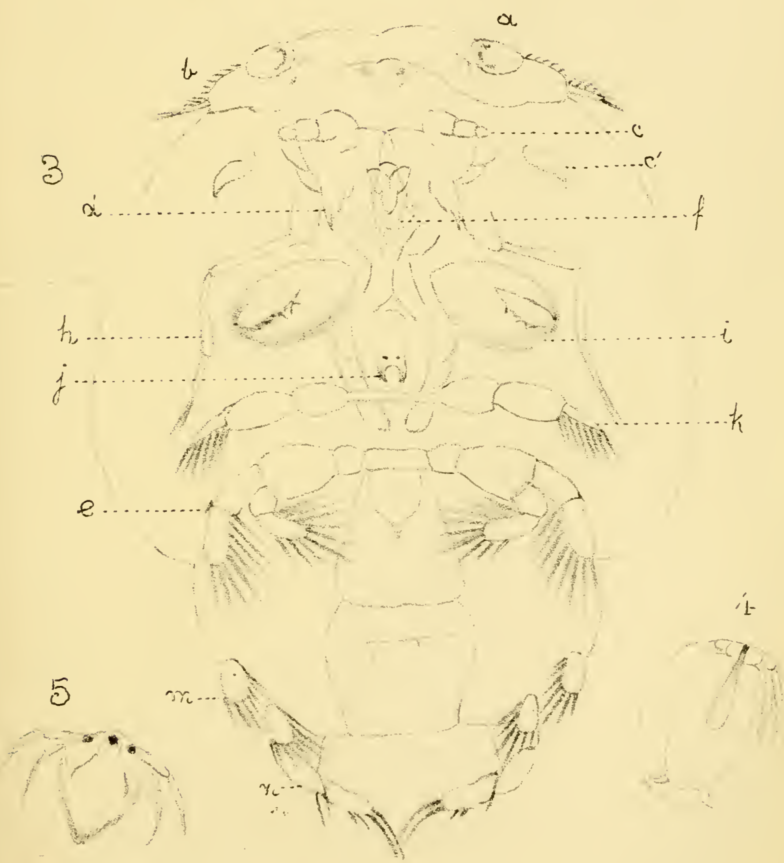
m
2
×51
ch'

Dermanyssi.

Gizzard of Foreign Cockroach.



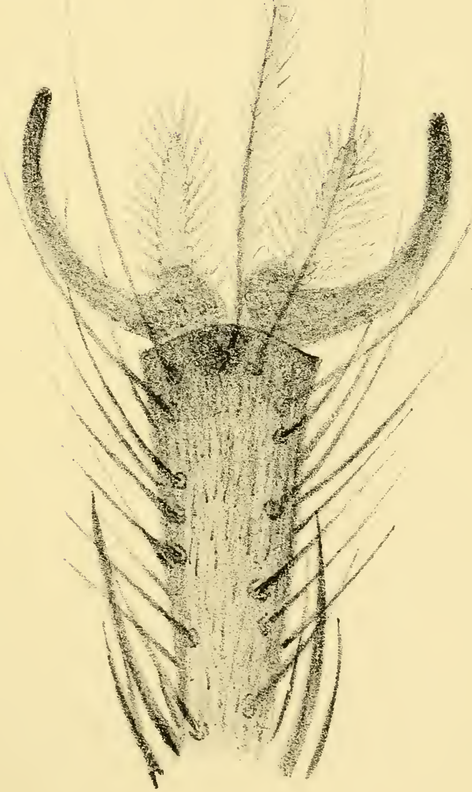
Caligus diaphanus.

1

Spicules of Spongilla fluviatilis.

3

2



Foot of Fly.

Fig. 4.—Ovum of Caligus.
,, 5.—Very young Caligus.

PLATE XVI.

Upper Portion.

Fig. 1.—Immature spicules of *Spongilla fluviatilis.*

Drawn by Jas. Fullagar.

Lower Portion.

,, 2.—Foot of fly found in corners.
,, 3.—Shows their method of congregating together.

Drawn by E. Tutte.

Plates XV. and XVI. are unavoidably deferred ; they will be given in our next.

Reviews.

AMERICAN MEDICINAL PLANTS: An Illustrated and Descriptive Guide to the American Plants as used as Homœopathic Remedies; their History, Preparation, Chemistry, and Physiological Effects. By Charles F. Millspaugh, M.D. Fascicle III. (New York: Bœricke and Tafel. 1886.) Price $5.

It gives us much pleasure to call attention to the third instalment of this grand work. The part before us contains 30 beautifully coloured large 4to plates, drawn from nature and of natural size. The text accompanying each plate is well printed and thoroughly descriptive, and the work when completed will prove a valuable addition to the library, whether of the Homœopathic or Allopathic Practitioner. Fascicle IV. will be ready shortly.

Gray's Botanical Text-Books. Sixth Edition.

VOL. I., STRUCTURAL BOTANY; or, Organography on the Basis of Morphology, to which is added the Principles of Taxonomy and Phytography, and a Glossary of Botanical Terms. By Asa Gray, LL.D., etc. 8vo, pp. xii.—442.

VOL. II., PHYSIOLOGICAL BOTANY. Part I., Outlines of the Histology of Phænogamous Plants; Part II., Vegetable Histology. By George Lincoln Goodale, A.M., M.D. 8vo, pp. xxi., 499—36. (New York: Ivison, Blakeman, Taylor, and Co. 1885.) Price $2.30 each.

Professor Asa Gray is certainly indefatigable. In his 75th year he has brought out a sixth edition of his very valuable text-book; and with him we know that a new edition means a thorough re-writing and re-arranging the whole matter. The present work will consist of four volumes, and will, when finished, form a most valuable and complete system of Botany. Of the two volumes before us the first is written by Professor Asa Gray himself, and is

devoted to "Structural Botany;" it contains many additions not found in former editions—notably, the chapter on the "Adaptations of the Flower to the Act of Fertilization."

The second volume, by Professor Goodale, is also a complete botanical work in itself, but treats specially of the Microscopic Structure, Development, and Functions of Phænogamous plants, their Physiology being treated in a most efficient manner. Vols. III. and IV. are in preparation. The series will prove invaluable to the advanced botanical student.

HANDBOOK OF MOSSES, with an account of their Structure, Classification, Geographical Distribution, and Habitats. By James E. Bagnall, A.L.S., Vice-Pres. of the Birmingham Natural History and Microscopical Society. Post 8vo, pp. vii.—96. (London: Swan Sonnenschein and Co. 1886.) Price 1s.

A very handy and useful book for the young collector, nicely illustrated with about 40 engravings. We cordially endorse the words of the author when he says:—"Study Mosses; no objects are more readily found. And if you desire a study which will present you with a constant supply of interesting objects—whether you take the varieties of leaf form, or notice the elegant designs of the little capsules; . . . . if you desire a study which will find you employment the whole year round, let me advise you to study Mosses."

A COURSE OF PRACTICAL INSTRUCTIONS IN BOTANY. By F. O. Bower, M.A., F.L.S., and Sydney H. Vines, M.A., D.Sc., F.L.S. With a Preface by W. T. Thiselton Dyer, M.A., C.M.G., F.R.S., F.L.S. Part I., Phanerogamæ—Pteridophyta. Crown 8vo, pp. xi.—226. (London: Macmillan and Co., 1885.) Price 6s.

A valuable work for the practical botanist, dealing entirely with the preparation of the different tissues of plants and their examination under the microscope. A list of the various staining media and chemical re-agents, with directions for cutting and mounting sections; followed by a study of the Phanerogamæ and Pteridophyta, in which the tissues and organs are carefully and accurately described, with practical directions for their microscopical examination. It also explains how to cultivate the Pteridophyta from the spores. We can highly recommend this book.

AN INTRODUCTION TO PRACTICAL BACTERIOLOGY, based upon the methods of Koch. By Edgar M. Crookshank, M.B.Lond., F.R.M.S., etc., Demonstrator of Physiology, King's Coll., London. (London: H. K. Lewis. 1886.) 8vo, pp. xxii.—249. Price 14s.

This valuable work, which embodies the notes made by the author in various laboratories, is intended to help the student beginning the study of Bacteriology. The methods of pure cultivation of the *Bacteria* are very concisely given. In Part I. we have a description of Apparatus, Materials, and Re-agents employed in a Bacteriological Laboratory; Microscopical Examination of Bacteria in Liquids; Cultivations on Solid Media and in Tissues; Preparation and Staining of Tissue Sections; Preparation of Nutrient Media and Methods of Cultivation; Experiments upon the Living Animal; Examination of Animals Experimented upon; and the Methods of Isolating Micro-Organisms from the Living and Dead subject. Part II. is systematic and descriptive, with special microscopical methods. The work is illustrated with 30 plates (many of them are beautifully coloured), and 42 wood engravings.

SYNOPSIS OF THE FRESH-WATER RHIZOPODS: A Condensed Account of the Genera and Species, founded upon Professor Joseph Leidy's "Fresh-Water Rhizopods of North America." Compiled by Romyn Hitchcock, F.R.M.S. Crown 8vo; pp. viii.—58. (Washington, U.S.A.: Romyn Hitchcock. 1881.)

This is a synopsis of Professor Leidy's grand work on the Fresh-Water Rhizopods, giving the general characteristics of the Rhizopods, and a brief description of the Genera and Species.

CLINICAL THERAPEUTICS: Lectures in Practical Medicine, delivered in the Hospital St. Antoine, Paris, by Prof. Dujurdin-Beaumetz. Translated by E. P. Hurd, M.D. Royal 8vo; pp. xvii.—491 (Detroit, Mich., U.S.A.: Geo. S. Davis. 1885.) Price $4.

The eminence of the author of this important work as a teacher of practical therapeutics, is so well known that the book has already run through four editions in French, and has been translated into the Spanish, Italian, Greek, and Russian languages; it is written in an interesting style, and discusses practically and thoroughly the most modern methods of treatment. There is a full index.

LEWIS'S POCKET MEDICAL VOCABULARY. 16mo, pp. 215. (London: W. K. Lewis. 1886.) Price 3s. 6d.

A most useful pocket companion for the medical student. The principal words are printed in heavy black letters (Clarendon), thus making it most easy and convenient for reference; in many cases, the Greek root is given.

THE PRINCIPLES OF POLITICAL ECONOMY. By Simon Newcomb, Ph.D., LL.D. 8vo, pp. xvi.—548. (New York: Harper Bros. 1886.)

This work is intended to embody an exposition of those principles of economic science which must be mastered by every one who would form an intelligent judgment of the causes which influence the public well-being. It is divided into the following sections:—I. The Logical Basis and Method of Economic Science. II. A description of the Social Organism. III. The Laws of Supply and Demand. IV. The Societary Circulation. V. The Application of Economic Science.

A GEOGRAPHICAL TEXT BOOK for Beginners. By William B. Irvine. 4to, pp. 32. (London: Relfe Bros.) Price 1s.

A capital little book, containing much information in small space. There are eleven clearly printed and nicely coloured maps.

THE LAKE DWELLINGS OF IRELAND; or, Ancient Lacustrine Habitations of Erin, commonly called Crannogs. By W. G. Wood-Martin, M.R.I.A., F.R.H.A.A.I., Lieut.-Colonel 8th Brigade North Irish Division R.A.; royal 8vo, pp. xxii.—268. (Dublin: Hodges, Figgis, and Co. London: Longmans, Green, and Co. 1886.) Price 25s.

Any contribution to our knowledge of the Lacustrine Dwellers is welcome, specially because they formed a link between prehistoric and the present time, and also because our more accurate information respecting the Dwellings themselves is of such recent acquirement.

But the work before us has additional claims upon us: it gives us informa-

tion about a country close to our shores, and respecting which there is so little actually known on this side of the Irish Channel, and our interest is considerably increased by finding that these Lake dwellings were in use in Ireland down to a much later period than in other countries—in Switzerland, for example. One is mentioned in the County of Derry as inhabited as a fortress in 1643.

The book is written by one who evidently took pleasure in his work, and who by culture and observation was well fitted for the task. It is extremely well illustrated.

It is difficult to select any one chapter of greater interest than another in a book like this, which is all interesting; but we found most attractive that part at the beginning which treats of cannons and weapons belonging to the Lake dwellings, and that other part at the end of the book which is entitled "Historical Notices of Crannogs." The number of Lake dwellings in Ireland is given as two hundred and twenty-one, but this must be under the mark, as there is one not noticed near Barnesmore, in county Donegal, where was found the remains of a man dressed in skin. We commend the book to the public.

A Treatise on Analytical Geometry of the Point, Line, Circle, and Conic Sections; containing an account of its most recent extensions, with numerous examples. By John Casey, LL.D., F.R.S. Crown 8vo, pp. xviii.—331. (Dublin: Hodges, Figgis and Co. London: Longmans, Green, and Co. 1885.) Price 7s. 6d.

In this work the author gives a comprehensive account of the Analytical Geometry of the Conic Sections, including the most recent additions to the Science.

The work is somewhat of an advanced character. There are a great number of exercises for the student; those following the examples being less difficult than those at the end of the book. We are sorry to notice so long a list of errata, but this will most probably be avoided in subsequent editions.

Geometrical Drawing; comprising the use of Scales and Practical Geometry, with numerous examples. By Rev. J. H. Robson, M.A., LL.D. Second edition, revised and enlarged, crown 8vo, pp. 162. (London: Relfe Bros. 1886.) Price 3s. 6d.

The work before us has a well-executed plate of Geometrical Scales. The exercises throughout are carefully explained. The subject-matter of the present edition has been wholly re-arranged, the problems on the Straight Line, Triangle, Circle, Polygon, and Quadrilateral being placed in separate chapters. The book will doubtless be found useful by young students.

Helps to Higher Arithmetic, for the use of Schools and Candidates for the Public Examinations. By the Rev. G. F. Allfree, M.A., St. John's Coll., Camb., and T. F. Scudamore, B.A., Christ's Coll., Camb. (London: Hamilton, Adams, and Co. Brighton: H. and C. Treacher. 1885.) Crown 8vo, price 3s. 6d.

If not *the best*, this is one of the best, books of the kind we have met with. It is divided into 20 sections, and contains nearly 150 examples worked out and *fully explained;* the worked-out examples in each section are followed by a collection of exercises sufficient to make the learner thoroughly acquainted with the subject under discussion. After the different sections have been thoroughly treated, 1,200 miscellaneous questions are given. The method of working out the various examples, and the arguments employed, are so clearly given that the student is sure to go through them with pleasure.

A PRACTICAL ARITHMETIC. By G. A. Wentworth, A.M., and Rev. Thos. Hill, D.D., LL.D. For High Schools and Academies. Crown 8vo, pp. xvi.—351. (Boston : Ginn and Co. 1885.)

This is a very useful book ; the method of teaching is in some cases slightly different from that to which we have been accustomed. We notice that decimal fractions are introduced at the beginning of the book ; this is doubtless owing to the American currency. They are more fully explained at a later period. Many of the rules are quite new to us, and very practical.

ELEMENTS OF INORGANIC CHEMISTRY : Descriptive and Qualitative. By James H. Shepard, Instructor in Chemistry, Ypsilanti High School ; crown 8vo, pp. xix.—377. (London : G. F. Putnams and Sons, 27, King William Street, Strand. Boston, U.S.A. : D. C. Heath and Co. 1885.)

This in the hands of an efficient teacher will prove a very useful book for junior pupils who have facilities for practical work in a good laboratory.

We notice the author coins the word "chemism" as a substitute for our more general, and we think preferable term, "Chemical affinity;" the word "valence" is also used for "valency." The book is nicely got up, and has about 20 illustrations.

THE HUMAN BODY and its Structure, with Hints on Health. A Practical Treatise on the Design, Nature, and Functions of the various parts of the Human Frame. Post 8vo, pp. viii.—175. (London : Ward, Lock, and Co.) Price 1s.

The design of this book is to give a practical treatise on the nature and construction of the human body, exemplifying its structure, the philosophy of the various organs, tissues, bones, muscles, etc. ; it contains in a popular form many of the principles of anatomy and physiology ; it is well illustrated with 86 wood engravings.

ILLUSTRATED LECTURES ON AMBULANCE WORK. By R. Lawton Roberts, M.D. Post 8vo, pp. xiv.—171. Price . (London : H. K. Lewis. 1885.)

These lectures were originally delivered to Ambulance Classes, held in connection with the Winnstay and other Collieries to members, who consisted chiefly of colliers, furnace-men, fitters, carpenters, &c., and who displayed remarkable aptitude in the pursuit of their studies.

The lectures embrace all the points laid down in the Syllabus of Instruction issued by the St. John's Ambulance Association, are very pleasantly written, and exceedingly well illustrated. The book is nicely got up.

DIET FOR THE SICK : A Treatise on the value of Foods, their application to special conditions of Health and Disease, and on the best methods of their preparation. By Mrs. Mary F. Henderson. Crown 8vo, pp. ix.—234. (New York : Harper Bros. 1885.)

The author tells us "A proper dietary is surely as essential to the recovery of an invalid as medicine ; and yet it will be observed that medical works give a thousand pages to medical therapeutics to one of dietaries."

The work before us gives us some remarks about Beverages and Foods ; New Health Foods ; Artificial Digestion by means of Pancreatic Ferments ; Grape Juice ; Diet in Different Diseases, &c. ; Receipts for the Sick and Convalescent, &c., &c. It will be found useful in the Sick-room.

BUZ; or, The Life and Adventures of a Honey-Bee. By Maurice Noel. Fscap. 4to, pp. 140. (Bristol: J. W. Arrowsmith. London: Simpkin, Marshall, and Co.)

A pretty little story, in which is interwoven an interesting account of the honey-bee. The narrative, except such parts of it as are obviously imaginary, describes nothing that the author has not witnessed in his own hives. The frontispiece, drawn by Linley Sambourne, represents the bee in conversation with a butterfly and a snail.

DOMESTIC ANNALS OF SCOTLAND, from the Reformation to the end of the Rebellion of 1745. By Robert Chambers, LL.D., F.R.S.E., etc. Crown 8vo, pp. 416. (Edinburgh and London: W. and R. Chambers. 1885.) Price 5s.

We heartily commend this book to our readers. It brings to light in a very forcible manner the historical, political, and religious circumstances of the times. It is nicely printed and well illustrated.

A GUIDE TO SANITARY HOUSE-INSPECTION; or, Hints and Helps regarding the Choice of a Healthful House in City or Country. By William Paul Gerhard, C.E. pp. 145. (New York: John Wiley and Son. 1885.)

We have in broad outline the main features of a sanitary house-inspection, the object of the author being to offer a guide in the search for defects, with useful hints for their rectification.

MANUEL DU TOURISTE PHOTOGRAPHE. Par M. Leon Vidal. Seconde partie, post 8vo, pp. 238. (Paris: Gauthier-Villars. 1885.)

It is now our pleasure to notice the second part of this useful French Manual, to the first part of which we called attention on page 125, Vol. IV. of this Journal. It contains some very valuable chapters on the requirements of instantaneous photography, and on the various classes of errors and failures that perplex and discourage the beginner. It is illustrated with several engravings and a photogélatinographique frontispiece.

PHOTOGRAPHIC MOSAICS: An Annual Record of Photographic Progress. Edited by Edward L. Wilson, Editor of the "Philadelphia Photographer." 12mo, pp. 144. (Philadelphia: E. L. Wilson. 1886.)

This annual, now in its twenty-second year, is not quite so large as our own Photographic Year-Book; it nevertheless contains a good deal of valuable information.

THE MODERN PRACTICE OF RE-TOUCHING, as Practiced by M. Piquepé and other Experts, French, English, and American. 8vo, pp. 38. (New York: Scovill Manufacturing Co. 1885.)

This is a second edition of Scovill's Photo Series, No. 7, and gives useful instructions in the various departments of re-touching negatives, prints, enlargements, etc., as practiced by the photographer.

ODDS AND ENDS OF USEFUL KNOWLEDGE for Junior Students preparing for Oxford or Cambridge Examinations. By a Lady. Post 8vo, pp. 36. (London: Relfe Bros.) Price 9d.

This little book is divided into four subjects, viz.—History, Geography, Odds and Ends, and Historical Dates.

A CLASSIFIED and Descriptive Catalogue of Scientific and Technical Books. 8vo, pp. iv.—216. (London: Geo. Phillip and Son. 1886.) Price 2s. 6d.

It often happens that we wish to read up certain subjects, but are at a loss to know what books are to be had that will give us the desired information. The Catalogue before us is what has been wanted for a long time. It is arranged according to subjects, which follow in alphabetical order, *e.g.*, Accoustics, Aërostation, Agriculture, etc., etc. Under each subject the books are alphabetically arranged, giving the author's name, title of book, size, publisher, and price. We notice date of publication is omitted, and that Scientific Journals are not mentioned. The book will, however, prove most useful, and we prophesy for it a large sale.

LEGENDS AND SUPERSTITIONS OF THE SEA AND OF SAILORS, in all Lands and at all Times. By Fletcher S. Bassett, Lieut. U.S. Navy. Cr. 8vo, pp. 505. (London: S. Low and Co. 1885.) Price 7s. 6d.

We have here a large collection of myths and folk-lore of the sea and its belongings; they are collected from various sources, and are told in a most interesting manner. The illustrations are good.

THE SISTERS SARAH AND ANGELINA GRIMKE, the First American Women Advocates of Abolition and Women's Rights. By Catherine H. Birney. pp. 319. (Boston, U.S.A.: Lee and Shepard. 1885.)

The volume before us gives an account of two good and noble women, who gave their lives to the active promotion of various reforms with fearlessness, independence, and devoted purpose to make the world better. The subject of slavery, with which they had been long and painfully familiar, troubled them, and they became openly abolitionists, and devoted themselves to the propagation of anti-slavery views; and as the younger sister had great elocutionary powers, her lectures were eagerly listened to. The book is a most interesting one.

WE TWO ALONE IN EUROPE. By Mary L. Ninde. Post 8vo, pp. 348. (Chicago, U.S.A.: Jansen McClurg and Co. 1886.)

A charmingly interesting account of the travels of two young ladies, who came over to England from America with their father, and then alone visited the principal cities of Europe, Cairo, the Pyramids, Palestine, and Athens. The trip appears to have occupied them two years, and to have been thoroughly enjoyed by them both. The book is dedicated to L.R.P., the other one of "We Two."

WITH PACK AND RIFLE in the Far South-West: Adventures in New Mexico, Arizona, and Central America. By Achilles Daunt. Post 8vo, pp. 389. (London: T. Nelson and Sons. 1886.) Price 5s.

Besides the numerous adventures and hair-breadth escapes described in this book, we have a good and accurate description of the Mexican prairies, and the foundation of the country. We have also an account of some of the ruined and buried cities. The book, which is well written and exceedingly interesting, is illustrated with 25 well-executed plates, and is nicely bound.

FRANK'S RANCHE, or my Holidays in the Rockies; being a contribution to the enquiry into what we are to do with our Boys. By the Author of "An Amateur Angler's Days in Dovedale." Fcap. 8vo, pp. xvi.—214. (London: Sampson Low and Co. Boston and New York: Houghton, Mifflin, and Co. 1886.) Price 5s.

In the book before us we have one of the most interesting accounts of a holiday that it has been our good fortune to read. The author starts for America in the good ship *Cunardia* to visit his son, who has taken a *Ranche* near the Gallatin River at the Foot of the Rocky Mountains. His travels are pleasantly described. The book contains many illustrations, prominent amongst them being Frank's Ranche, drawn by himself, a map of the route over which the author travelled, and several others. Useful hints are also given to the would-be emigrant.

Evolution and Religion. Part I. Eight Sermons Discussing the Bearings of the Evolutionary Philosophy of the Fundamental Doctrines of Evangelical Christianity. By Henry Ward Beecher. 8vo, pp. 145. (New York : Fords, Howard, and Hulbert. 1885.) Price 50c.

The author says, "For myself, while finding no need of changing my idea of the Divine personality because of new light upon His mode of working, I have hailed the Evolutionary Philosophy with joy." We have read these sermons with much interest, and cordially recommend them.

The Laws of Nature and the Laws of God : A Reply to Prof. Drummond. By Samuel Cockburn, M.D., L.R.C.S.E. Post 8vo, pp. 154. Price 3s. 6d.

The author of the book before us expresses a hope that he may, to some extent, neutralise what he describes as the "baneful effects resulting from the attempt now being made in different quarters to square the teachings of revealed religion with the uncertain findings and ever-changing speculations of modern science and philosophy." The book is well written, and the arguments consistent.

Famous Caves and Catacombs Described and Illustrated. By W. H. Davenport Adams. Crown 8vo, pp. xii.—204. (London : T. Nelson and Son. 1886.) Price 2s.

An account is here given of some of the most famous Caves and Cave-temples in the world, in which the researches of modern antiquaries have discovered the remains of a prehistoric age :—The caves of Ancient Egypt, Ancient Hindustan, Ancient Greece, the Caves and Catacombs of Ancient Rome, the Grottoes of Modern Times, including the Catacombs of Paris. The book contains some 40 plates and illustrations, and gives some very useful and interesting information.

To the Members of the Postal Microscopical Society.

It is necessary that the slides now in circulation should be exchanged. The Hon. Sec. will be glad if Members will let him have six or twelve slides, with notes, at their earliest convenience, and will be pleased to send MS. book for notes on application. If Members will send the slides in one of their own boxes, he will return it as soon as possible with their own slides now in circulation. Please let him have slides by the middle of April.

By Rule 10 it is arranged, "That Members of the General Section who are unable or unwilling to circulate slides may compound for the same by paying an *Extra Annual Subscription* of 5/-," but slides are just now urgently required.

THE JOURNAL OF MICROSCOPY

AND

NATURAL SCIENCE:

THE JOURNAL OF

THE POSTAL MICROSCOPICAL SOCIETY.

JULY, 1886.

Anagallis arvensis.

BY R. H. MOORE.

PLATES 17, 18, 19.

THIS little plant with its bright scarlet flowers profusely ornaments, as its specific name indicates, our corn-fields. It is the only British wild plant, with the exception of the more showy but delicately petalled Poppy, which possesses a corolla of pure scarlet. It is one of those miniature gems in the floral world which must be searched for to be admired. The children who are captivated by the more showy blossoms of heath and meadow pass it by, and we seldom see its gay little petals in a bouquet of wild flowers. It is, however, a favourite with the botánist, and has inspired the song of many a poet:—

"With its eye of gold
And scarlet, starry points of flowers,
Pimpernel dreading nights and showers."

One of its characteristics thus alluded to has never been forgotten. It is one of those sensitive little flowers which opens and closes its petals according to atmospheric changes; hence it is supposed to be an infallible weather guide; a field barometer, which the rustic studies, and arranges his work from its appearance.

This curious trait in the Pimpernel has given it the significant name of Shepherd's weather glass, and is alluded to by many early writers. Even Lord Bacon referred to it as a flower which, if not open in the morning, was a sure indication of a rainy day. This peculiarity of the Anagallis enabled Linnæus to include it in his botanical clock, and its habit is stated to be to open every morning at eight minutes past seven, and to close its petals at three minutes past two p.m., but authorities differ slightly as to the exact minutes. It generic name is said to come from the Greek "αναγελάω"—"to laugh," because of its supposed cure for mania, or for its efficacy in liver complaints. One old medical recipe is as follows:—20 grains of the powdered herb placed in a strong infusion of the plant, and 15 drops of hartshorn added, to be given every six hours, is a sure remedy for hydrophobia. It was alleged to be serviceable in consumptive cases, in failing eyesight, and in cases of epilepsy, so that, independently of its beauty, it made a mark in the archives of ancient medical science.

In the artificial system of botany it was placed in the Class Pentandria, Order Monogynia. In the natural system it is found in the Order PRIMULACEÆ, genus *Anagallis*, No. 1049, of the London Catalogue, 7th edition; and there is a very good description of our little favourite in page 90 of *Lindley's School Botany*, with excellent drawings to accompany the text. Of the genus *Anagallis* there are only three species in the British Flora: *A. arvensis*, *A. cærulea*, and *A. tenella*, known respectively by the common names of Scarlet, Blue, and Bog Pimpernel. Some botanists have considered that *A. cærulea* is but a variety of *A. arvensis*, but it has a separate number allotted to it in the London Catalogue. Like many others of our common flowers, it is found in all temperate regions of the globe, and follows the civilisation of man. It inhabits Persia, China, Cape of Good Hope, Egypt, United States, and Mexico, but it shuns the arctic regions and the tropical districts. The Bog Pimpernel, *A. tenella*,

is perennial; the Scarlet, *A. arvensis*, is an annual. The former blooms only in July and August, the latter from May to November. It is included in the same natural order as the Oxlip, Cowslip, Primrose, Auricula, and Cyclamen. The inflorescence consists of a single flower surmounting a long stem, which springs from the axil of each leaf. The leaves are opposite, and thus there is a pair of flowers springing from the bases of each pair of leaves. (See Pl. XVII., Fig. 1.)

The calyx of the Anagallis has five divisions or sepals united at the base, and the sepals are distinctly seen in the open blossom extending between the deep clefts of the corolla. The corolla is of a beautiful scarlet colour, monopetalous, rotate, and with five lobes. The five stamens are attached to the corolla, and when the latter is fully expanded, they lie almost flat upon its lobes. The anthers, covered with pollen, appear like nuggets of gold upon the scarlet back ground, and the purple ring at the base of the corolla adds much to the beauty of the floral display. The ovary is globose, with a pink coloured style and capitate summit. The capsule opens with a lid, the upper half being dehiscent, so that the seeds, when the lid has fallen off, are seen closely packed together in a miniature cup. (See Fig. 2.)

The floral structure may be represented by a pentagon of five equal sides, all the angles equidistant from its centre: five calyx sepals, five corolla lobes, five stamens, all either uniting or lying in close proximity at the centre of a mathematical pentagon. Artists have caught the inspiration of Nature, and the beautiful traceries of our church windows and other ornamental designs are hers by sovereign right. Emerson eloquently observes—"The Gothic Cathedral is a blossoming in stone subdued by the insatiable demand of harmony in man; the mountain of granite blooms into an eternal flower, with the lightness and delicate finish, as well as with the aerial proportions and perspective of vegetable beauty."

My description of the *Anagallis arvensis* has been hitherto connected with beauty which can be seen without the aid of the microscope, and even in this, one is led to exclaim with Tegner—

> "If so much of beauty doth reveal
> Itself in every vein of life and nature,
> How beautiful must be the source itself—
> The Ever Bright One."

As this, however, is intended to be a microscopical paper, I will attempt to describe the hidden beauties of this exquisite little wild flower, commencing with The Root, which is fibrous, of a dark brown colour, and having a few knots in its structure. There is nothing particularly striking in its appearance under the microscope. The more delicate fibres are branched, with an external development of large, somewhat rectangular cells, which surround a darker central system of dotted tubes closely packed together.

The Stem of *Anagallis arvensis* is procumbent, dividing into several branches, which trail over the ground on every side of the point of attachment to the earth. The stems are acutely angled, although they appear of square form to the unassisted eye. Under the microscope they show a partially winged character at each of the four angles (see Fig 4). The transverse sections which I have prepared show the beautiful chains of single cells which ornament the exterior portion of the stem. The epidermal cuticle is sparsely covered with minute glandular hairs, and the stomata are readily distinguished upon the epidermal tissue. In transverse sections of the stem, the exogenous character of the plant is well seen, the pith surrounded by the fibro-vascular bundles which divide it from the outer cortical bark-cells, and these are enclosed by the epidermis. The central portion of the pith is composed of very large, irregular-formed cells. Outside these are cells of hexagonal form, and we may suppose that in the most mature stems the centre would become quite hollow. The fibro-vascular bundles which surround the pith are packed very closely together, giving strength and solidity to the stem. The spiral fibre may be seen very distinctly in stained and mounted preparations, as in Fig. 5. This spiral fibre, or tracheæ, as it is sometimes called, appears of flat ribbon-like character, and forms a beautiful object under the ¼-inch objective. Exterior to the fibro-vascular bundles the woody fibre is found composed of fusiform tubes mixed with dotted cells, while some of the fibro-vascular tissue shows a decided annular structure (Fig. 6). The fibro-vascular and the woody cells so completely surround the pith, that they appear at first sight to form an impenetrable sheath around the medulla, but careful focussing will show communications from pith to bark, which in older stems would become the medullary rays of the exogenous division of the

vegetable world. The fibro-vascular tissue is not only very dense, but also very closely attached, so that long soaking and patient teasing is required to display the spiral tissue. The logwood stain which I have used upon the specimens has given to the spiral tissue a pretty effect, and the advantage of being easily distinguishable. The growth from spiral to annular tissue is also readily seen, and the staining of the tissue has rendered the dotted ducts very distinct. In vegetable physiology, the spiral tissue contains the air, while the ducts convey the sap from the root, through the stem, to the leaves of the plant. Some of the ducts upon the slides show also the scalariform character.

THE LEAVES of *Anagallis arvensis* are opposite : some are ovate, others lanceolate, generally sessile, although some of them possess a short stalk. The leaves are reticulated, with a dark green upper surface, and a lighter green with a greyish tinge beneath. The under surface abounds in dots, which on examination appear like clusters of coloured cells of a reddish tint, and which appear at intervals as coloured dots showing through the thin epidermal tissue. The leaves are destitute of hairs, and appear to the naked eye entire, but under the microscope they display a pretty papilla-like fringe of single cells running from the apex half way down the margin of each leaf (see Fig. 7). The upper cuticle is not readily detached, its cells are sinuous with thick cell-walls, and are freely covered with stomata. The under cuticle can be easily stripped. The cell-walls are also sinuous, but of a finer character than those of the upper cuticle, and the stomata are far more abundant (Figs. 8—9). I have not detected any crystals in the leaves which have been decolourised and stained, and they show no striking features beyond the venation and cellular tissue.

THE FLOWER of the Scarlet Pimpernel is the most attractive portion of the plant. I have already sketched its external beauty, and will now treat of its anatomy. To the ordinary observer it appears to have five petals, but if the botanist removes it from its calyx, it is found to have but one petal with five deeply cut lobes. Each lobe is seen under the microscope to be fringed with minute glandular hairs. In *Lindley's School Botany* the petal is described as being minutely notched, but a very low-power objective will show that this description is not correct. The notched appearance is easily

resolved into a margin of glandular hairs, which extend some distance on either side of each lobe towards the point of union with the remaining lobes (see Fig. 10). Under a $\frac{1}{4}$-inch objective the dry mounted lobes display these hairs with a globose head of rich ruby colour on a transparent stalk attached to a papilla-like cell on the margin of the lobe. Some of them are turban-shaped. The hairs are referred to in some microscopical descriptions of the petal, but no one, so far as I can gather, has ventured a theory as to the part they act in this particular plant. The surface of the petal is quite free from them, but they are found very sparsely scattered upon the sepals and stem of the plant. I can detect no fragrance in the flower which would identify these hairs with the oily secretions which exist in such plants as the Lavender, Sweet Briar, or the *Primula sinensis*. Their office, however, may be to absorb rather than secrete. Darwin, in his "Insectivorous Plants," states that "the glandular hairs of ordinary plants have generally been considered by physiologists to serve only as secreting organs, but we now know that they have the power, at least in some cases, of absorbing both a solution and the vapour of ammonia. As rain water contains a small percentage of ammonia, and the atmosphere a minute portion of carbonate, their power can hardly fail to be beneficial, nor can the benefit be quite so insignificant as it might at first be thought, for a moderately fine plant of *Primula sinensis* bears the astonishing number of about $2\frac{1}{2}$ millions of glandular hairs, all of which are able to absorb ammonia brought to them by the rain." In the light of this quotation, I should consider the hairs upon the corolla and other portions of the Anagallis to be organs of absorption. The lobes of the corolla of this flower are densely packed with masses of spiral fibre which penetrate into them from the flower stem, and undoubtedly these organs, either from the dampness of the atmosphere, or the declining heat of the sun, preserve their moisture, and the spiral contraction which ensues closes the corolla in the pyramidal form so often noticed in this pretty flower.

In considering the motile and irritable parts of plants, Sachs alludes to the phenomena, known as the Waking and Sleeping of plants, and he gives many illustrations of the habit, although he has not dwelt upon this particular flower. His remarks, however,

will, I think, throw some light upon the opening and closing of the Anagallis. He states, that "many petals are sensitive to warmth in such a way, that any increase of temperature causes such a curvature of the contractile organs as to place the petals in an expanded and completely unfolded position, while any decrease in the temperature produces the opposite curvature, causing the petals to fold up," In the one case, we have the waking or diurnal position, in the other the sleeping or nocturnal position. As stated earlier in this paper, the Anagallis closes soon after 2 p.m., even in the hottest days, and remains closed until a little after 7 a.m. If the increasing heat of the sun expands the spiral fibre of the corolla lobes so early in the day, there is a difficulty in understanding why after 2 p.m., when the heat of the sun is still of great intensity, the petals should gradually close into a sleeping position. I shall, however, again refer to this movement when I consider the fertilisation of the Anagallis.

The Calyx is divided into five sepals: inferior, regular, and persistent. The sepals are lanceolate, of equal length with the corolla lobes, and they form a close protection to the corolla. The upper portions of the sepals are slightly membranous or chaffy, and they are composed of large cells with thick cell-walls. On one side of the sepals there is a papilla-like series of cells which render them pretty objects for the microscope, and these cells are probably useful in interlocking the sepals when folded up, and protecting the corolla (see Fig. 11).

The Organs of Reproduction consist of five stamens inserted at the base of the corolla, the globose germen occupying the centre. The filaments of the stamens are exquisitely beautiful. From base to anther they are beautifully clothed with white and purple hairs, simple cells united at their edges to form miniature necklaces of pearls. In fresh flowers they present an irridiscent beauty never to be forgotten. Fig. 12 will afford some idea of the beauty of the filament decorations, but we lose a large portion of the charm when looking at artistic productions or mounted specimens. Each filament is surmounted by a heart-shaped anther gorgeous as gold. The anther lobes are literally packed with yellow pollen. When mounted in balsam the anthers polarise with fine colours, and they are fringed with cells formed with as

exquisite a regularity as the facets in the compound eyes of insects.

THE POLLEN grains, as shown in Fig. 13, are drawn from a dry mount by the neutral-tint reflector. They appear generally of an elliptic shape with a dotted surface, and a fissure running down the centre of each grain. But with careful focussing they are seen to be formed on the plan of a triangle with curved sides, and there are probably three sutures in the three angles. In some of the grains the appearance is as if the triangular-shaped grains are flattened at one of the extremities.

THE STYLE of the Pistil is rose-coloured in a fresh specimen, and the stigma is enlarged into fleshy lobes well adapted for receiving the pollen. The style also is closely packed with spiral fibre. The germen is globose, attached to the calyx, with a central placenta surrounding the ovules, each of the latter lying in a loculus or cavity of the placenta. The ovules vary in number; I have counted as many as twenty-four. They are composed of irregular-shaped cells filled with granular matter. They are stalked, and the funiculus or stalk which attaches the ovule to the placenta is at the base of the ovule; the foramen is near the base also, and through the latter the pollen tubes enter to discharge the fovilla of the pollen to fertilise the ovule. The drawing, Fig. 14, is copied from one of my slides; the staining of the ovule has clearly marked the central portion with a deeper shade of colour. This dark portion is the nucleus which will develope into the embryo of the mature seed.

THE SEEDS of *Anagallis arvensis* are enclosed in a globular capsule as large as a small pea. The capsules are dehiscent, the suture causing them when ripe to separate into two hemispheres, the upper one falling off, the lower half remaining as a cup, and exposing the dark brown seeds which are scattered around the parent plant. The capsule is termed a Pyxidium, and the Henbane is the only plant which has a capsule of similar character. The cellular structure of the capsule lid is worthy of observation. It is composed of large cells with richly-ornamented cell-walls prettily curved; the cells are distinguished by an interior deposit of a sclerogenous character. The drawing (Fig. 15) of this cellular formation was made under the neutral-tint reflector, and the slide from which it was copied gives a beautiful effect under polarised

light. The seeds, Fig. 16, are of trigonous shape with three angles and three semi-convex facets. The testa, or outer covering, is tubercular, and under the microscope appears to be composed of a number of pellets closely joined together. It is a good object for polarised light, which reveals a series of short prismatic crystals that are not detected except by the use of the polarising prisms. The testa is the only portion of the plant which contains crystals (see Fig. 18, *b*). The plant instinct in the distribution of seeds is an interesting study. The mature blossom is upright, but as it fades and the capsule matures, the spiral tissue of the stem contracts and curves downward until the capsule faces the earth, the lid falls of and the seeds are discharged upon the ground. In closing the life history of this little flower, I shall refer to its

FERTILISATION. Sir John Lubbock, in his interesting book on "British Wild Flowers considered in relation to Insects," calls attention also to the sleep of flowers. He suggests that the habit has reference to the visits of insects for the purpose of fertilisation. Flowers which require night-flying insects would have no occasion to open in the day; those which require such insects as bees would not have any advantage by opening at night. He states that the habit of closing preserves to the plants the honey and pollen, of which other insects than those useful to their fertilisation would deprive them. It is, however, questionable if the opening and closing of the *Anagallis arvensis* depend upon this agency alone, because Sir John Lubbock states in another part of his book, that in this particular flower the stamens and pistil ripen simultaneously, and that the flowers contain no honey.

He further states that the plant is seldom visited by insects, and that consequently it depends upon self-fertilisation. I am, therefore, inclined to think that the opening and closing of the flower is not perhaps so dependent upon the heat of the sun as the above quotation from Sachs may at first lead us to infer, especially when we remember that the Anagallis sleeps so soon after noontide heat. May we not rather look back upon the phenomenon as another instance of vegetable sagacity? The abundance of spiral tissue in the corolla has its special office to fulfil just at the right time and for a particular purpose, namely—the self-fertilisation of the ovules. The corolla lobes, stamens, and stigmatic surfaces are

all expanded and exposed for atmospheric agency to nourish, strengthen, and ripen them. When closely drawn together, the pollen is carefully preserved from continued heat, wind disturbance, waste from rain and insect depredation, and the operation of self-fertilisation is wonderfully secured. In its pyramidal form the corolla folds all its precious treasures securely within its bosom, simply for its own preservation.

I trust that, in writing this paper, I have shown how much of the beautiful may be discovered in one of the commonest objects by which we are surrounded, and that every one of them may not only afford the pleasures of investigation, but that they may be serviceable for the highest teaching.

> "The humblest flower is a poem by Him
> Who dwells 'midst the blazing cherubim.
> Read it well;
> It has something to tell.
> In rhythm of colour, it will confess,
> God loveth beauty and gentleness."

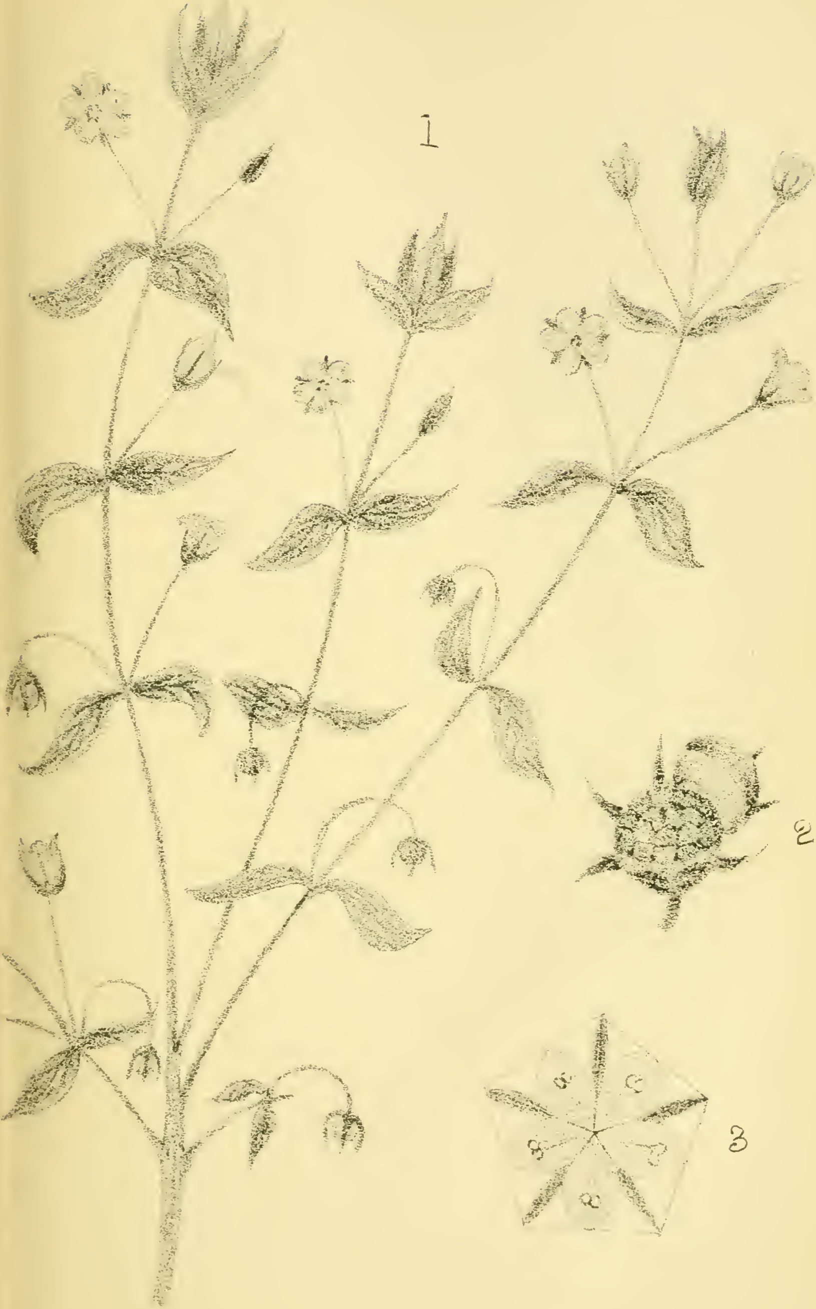
EXPLANATION OF PLATES XVII., XVIII., XIX.

Plate XVII.

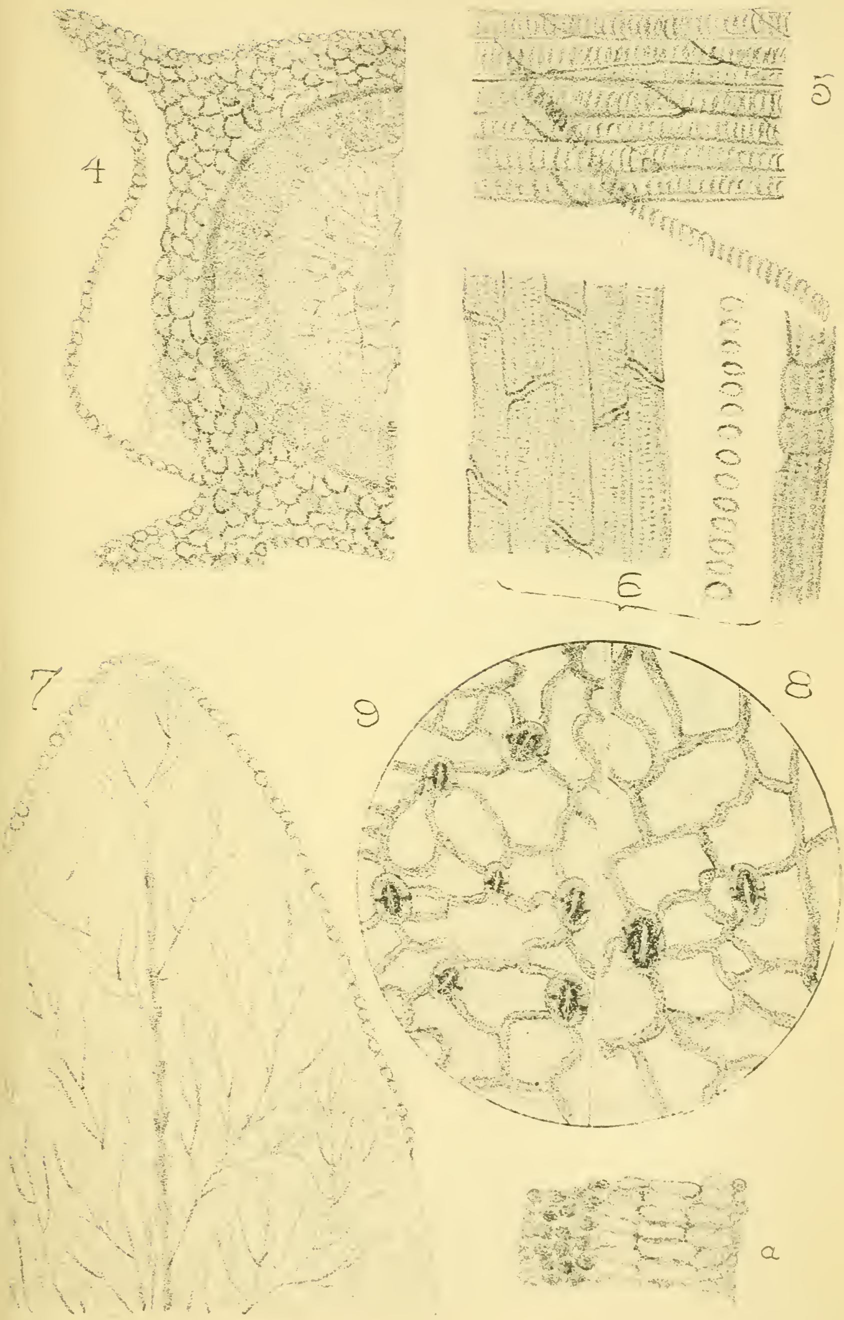
Fig. 1.—The Scarlet Pimpernel *(Anagallis arvensis)*, natural size.
,, 2.—Ripe Capsule, with fruit, slightly enlarged.
,, 3.—Diagrammatic form of blossom, showing the pentagonal shape.

Plate XVIII.

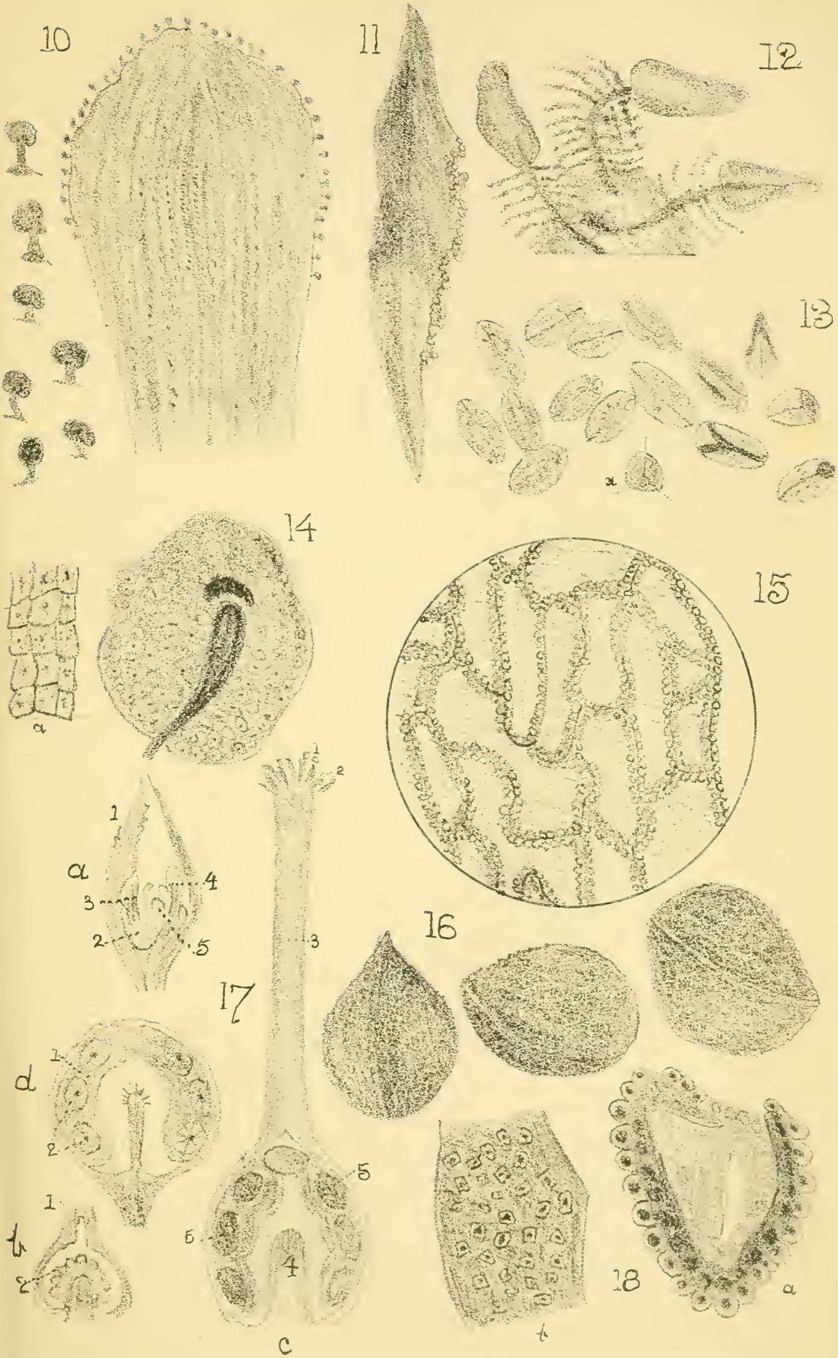
,, 4.—Transverse section of stem, × 40.
,, 5.—Spiral vessels in stem, × 210.
,, 6.—Pitted ducts and annular vessels of stem, × 210.
,, 7.—Portion of leaf drawn from a decolorised and stained specimen, showing venation and marginal cells, × 15.
a.—Transverse section of leaf, × 60.
,, 8.—Upper Cuticle of leaf, × 200.
,, 9.—Under Cuticle of leaf, × 200.



Anagallis arvensis.



Anagallis arvensis.



Anagallis arvensis.

PLATE XIX.

Fig. 10.—Lobe of the Corolla, × 15, and some of the glandular hairs from the same, × 200.

,, 11.—Sepal, × 15.

,, 12.—Three of the Stamens, × 15.

,, 13.—Pollen, × 285. *a*, Diagrammatic representation of a section of one of the grains.

,, 14.—Ovule, × 20. *a*, Portion of same, × 200.

,, 15.—Cellular structure of the Capsule, × 200.

,, 16.—Seeds (opaque), × 20.

,, 17.—Development of the Seeds, after *Sachs*.

a, Longitudinal section of flower-bud, showing, 1, Sepal; 2, Corolla; 3, Anther; 4, Carpel; 5, Apex of Floral axis.

b, Gynœcium further developed. 1, Stigmatic formation; 2, Ovular formation.

c, Section of Pistil and Ovary. 1, Pollen; 2, Stigma; 3, Style; 4, Central Placenta; 5, Ovules.

d, Fruit (unripe). 1, Placenta, fleshy and swollen, and filling spaces between Ovules; 2, Ovules.

,, 18.—*a*, Transverse section of seed (from a stained specimen, × 30.

b, Crystals in Testa seen by polarised light, × 200.

On the Power of Movement in Plants.

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THE power of movement in some form or other is an *essential* condition of *life*. We are quite unable to think of the two things apart from each other. I do not say that the movement is always spontaneous, or that it is the result of volition; far from it. Neither do I say that it must needs involve in all cases a *change of place*, or that it even extends throughout the *whole* organism, although this is in scores of instances exactly what takes place.

I speak just now concerning the phenomenon of *motion* as seen in the plant-realm, whether in part or as a whole; whether

involving change of locality, or not involving it; whether it be movement of a single cell, or a tissue of cells forming a plant, or even of only the contents of a cell.

It is quite impossible in a paper such as this to do more than outline the subject, and by so doing, to try to give some notion of the variety of movements to be met with, and, in some cases, to point to examples. My paper will therefore be, in the strictest sense, only an elementary chapter, written as it were with the presumption that my readers know absolutely nothing of the question, and that I am asked to try to tell them some simple facts, to lead them just over the threshold of our inquiry, and leave them there to pursue it for themselves.

I do not intend to speak of *passive movement* at all: I mean movement occurring as the result of external forces, such as wind, or wave, or the weight of fruit; nor of the means by which a bough denuded of its fruit-weight goes back to the position it occupied when that fruit existed only potentially in the blossom. All I say will have direct reference to *motion as the result of life and its processes*, admitting only the mention of such *external* forces as light and heat, to which an organism responds on virtue of the *life* which it possesses. It will be seen instantly that such response is active, and totally different from the passive movement above referred to, which would ensue in inanimate bodies just as much as in those endowed with life.

There are several varieties of movement of which we might speak, but we will confine ourselves to the chief of these, and where it is possible to do so, find out how the motion comes about and the use of such motion to the organism.

CLASS I.

Movements dependent upon the Protoplasm contained in Plant-cells, or upon the presence of Cilia, or small Hair-like Processes on their surfaces.

A.—Motion of the Contents of Cells.

This is seen to be of two kinds:

I.–*Rotation*, where the current courses only *along the walls* either spirally or reticulately. Remember, this is not, as it was formerly

thought to be, a movement of the watery cell-sap; it is that of the protoplasm making paths for itself in the cell-sap.

It may be seen in many plant-cells; notably in the Stoneworts, *Nitella* and *Chara*. In *Chara* it is the inner layer of protoplasm that rotates, carrying the nucleus with it, while the outer layer, or 'primordial utricle,' as it is called, immediately within the cell-wall remains motionless, as do also the chlorophyll grains. The motion in *Chara* is at an angle with the wall, not parallel to it. In *Vallisneria*, on the other hand, it goes on parallel to and all round the wall carrying the chlorophyll grains with it. It is beautifully seen in the bristles on the ovary of *Circæa*, the Enchanter's Nightshade. Cold retards it. Heat accelerates it. Electrical currents stop it, but it instantly sets off again on breaking the current. Jolting the cell, or pricking it, also stops it. Speed varies: in *Circæa* bristles, which are about half a 'line' long, it completes the round in about one minute; in *Vallisneria* it moves at the rate of the one-hundred-and-eightieth part of a line per second; sometimes in this plant much faster.

II.—*Circulation*, where the protoplasm is hollowed out and the motion is in *net-like currents* radiating from and returning to the nucleus, passing in threads and bands through the cell-sap.

This is seen in the cells of the purple hairs of *Tradescantia* (Spider-wort), in the cells of Celandine, in Nettle-hairs, and in many others. Here the movement is less regular and more spasmodic, now advancing, now retreating, now ceasing, now recommencing. The hairs on the buds of *Althæa*, the Marsh Mallow, show it exceedingly well.

The cause of these movements is still a subject for investigation. Endless theories have been and are being advanced, and held most pertinaciously by some observers, who think they can cry '*Eureka*,' and put an end to all further discussion. Generally speaking, we may write down the following as among the causes of movements inside cells:—

Constant Chemical Changes, such as the formation and evolution of carbonic acid, the formation of starch and the albuminoids; these cause successive changes in the equilibrium of forces and produce heat, and probably also electrical currents. These in turn give rise to forces of astounding magnitude, setting atoms and

molecules in motion, and representing an amount of 'work' that is often enormous. Starch, for instance, in dry grains absorbing water of the same temperature, will cause a rise of 2° or 3° C, while boiling water is only raised 0·078° C. by a pressure of ten atmospheres. Absorption of water alone then means the development of an enormous force.

Tension of Tissues or cells due to unequal growth of layers is another cause.

Turgidity, or pressure of cell-sap on the cell-wall, does its share in promoting motion by disturbance of equilibrium, turgidity being caused by attraction of water by the substances dissolved in the cell-sap.

Diffusion of Gases assists in the general bringing about of motion.

Light and *Heat* play an important part in the same direction, as is well seen in the action of these agents on chlorophyll grains and *Algæ* spores, causing them to visibly shift their positions.

So we may see evidence of the transformation of light and heat into energy and motion, and the law of the correlation of physical forces finds here abundant illustration. 'Heat as a mode of motion' can be said to find expression in the phenomenon of movement in cell-contents.

B.—Motion of Naked Cells, or Primordial Cells.

If protoplasm confined by a cell-wall can show such activity, we can very easily imagine that when not so enveloped, it might be able to move of its own accord *from one place to another*. This actually occurs in the abnormal group of *Fungi* called *Myxomycetes*. For instance, take *Æthalium* or 'flowers of tan,' an orange-coloured organism growing in and around tan-pits. It exists as a *plasmodium*, a mass of protoplasm with no cellulose wall, slimy or creamy in appearance, and made up of a number of anastomosing net-like channels, along which a pretty constant current of protoplasm passes, carrying all kinds of foreign bodies with it. This *plasmodium* moves slowly but freely from place to place by projecting at its edge a number of *pseudopodia*, or arm-like processes, into which this current of moving protoplasm flows, thus increasing their size; this has only to persist for a time, and the whole mass

has shifted its position. It has a singular tendency before its period of fructification ensues, to climb up any erect object like a tree, or stump, and here it may be found at rest forming its *capsule* containing spores which by-and-bye are set free as naked masses of protoplasm; these *myxamœbæ*, as they are called, coalesce later on, three or four of them or more making a *plasmodium* such as we started with; *they* are also endowed with power of motion, using this power in order to coalesce. The *plasmodium* of *Didymium* will travel as fast as ten millimetres in a minute.

A similar power is seen in the protoplasmic filaments ejected from the glandular hairs on the leaves of the Common Teasel, where Mr. F. Darwin has proved their power of absorbing nutriment from the bodies of insects drowned in water contained in the cups formed by the connate leaves. It is seen also in the cups of the leaves of the celebrated Compass plant of the prairies. Here the power of movement, as in our first case (cell-contents), has to do with the protoplasm, and is quite independent of any external agent.

C.—Motion of Embryonic Cells, or 'Zoospores,' and of 'Antherozoids.'

This is accomplished by means of vibratile cilia with which the organisms are provided. These forms are seen in two chief varieties:

I.—*The Zoospores or Swarmspores* of certain *Algæ*, for instance, *Protococcus*, the Red Snow Plant, *Ædogonium*, *Vaucheria*, etc., and of some *Fungi*, such as *Peronospora infestans*, the Potato fungus; they consist of embryonic cells set free by rupture of the parent-cell, and are naked masses of protoplasm provided with these cilia, but destitute of any cell-wall during their motile period; they move with astonishing rapidity, sometimes rotating on their own axis, sometimes with a comical rolling motion, lashing the water with one cilium, while the other trails behind, sometimes fixing themselves by one cilium and spinning round on it by means of the other; after a time, they lose their cilia, develop a cellulose coat, become respectable members of society, and having "sown their wild oats," gradually grow up to adult forms.

II.—*The Antherozoids* or male elements of reproduction formed

within, and set free from the *Antheridia* of some *Algæ*, and also of *Characeæ*, Ferns, and other higher Cryptogams; these resemble the Zoospores in their appearance and motile power, although their mission is of course a different one.

In both these cases the *cilia* are the agents of motion, but the internal causes of the movement of the cilia themselves are still among the unknown, let us hope not among the unknowable. The general opinion, so far, is that the causes are analogous to those of the rotation of protoplasm already referred to.

D.—Motion of Entire and Adult Plants.

This is abundantly met with. In many cases—as for instance in the adult *Protococcus*, and in the 'cell-families,' such as *Volvox globator*, where several unicellular *Algæ* unite to form a colony—the motion iseffected by cilia. In others—such as the *Oscillatoriæ*, a filamentous group of *Algæ*, and the *Schizomycetes*, containing *Bacterium*, *Vibrio*, *Spirillum*, and *Leptothrix*, Algæ which are just now supposed to be the quite innocent causes of nearly all the diseases to which we can possibly succumb—there are no cilia, and yet their vibratile, oscillating, and creeping movements are perfectly well known, although the causes and mechanics of such movements are still involved in obscurity.

In the Diatoms again, we find brisk activity, and yet no cilia, so far as we know. It is supposed either that they move by minute projections of protoplasm through spots in their shells (something after the fashion of *Echinus*), or that it depends on osmotic currents, due to interchange of matter between their cell-contents and the water in which they live.

It would be well if a considerable portion of the valuable time and talent devoted to investigating the marking of their shells were spent in working out their life-history, of which next to nothing is known. May be, we should be able to lay part of the odium now showered on the poor unfortunate *Schizomycetes*, upon their brethren the *Conjugatæ!*

CLASS II.

Movements purely Mechanical and due to Physical Causes.

I say purely Mechanical, because there are many other move-

ments seemingly so, but which we cannot explain by physical causes alone; of these presently.

In this Class are included the bursting of spore-cases in Cryptogams; for instance, the rupture of the *sporangia* in Ferns, the breaking away of the *opercula* in Mosses, and the unwinding of the elastic *elaters* on the spores of Equisetums. Also the dehiscence, or bursting of anther-cells for the escape of the fertilizing pollen, and the dehiscence of the Fruit in Flowering plants.

All these are cases of 'warping,' so to speak, and are the destruction of parts in a sense 'dead,' resulting from some intrinsic structural conditions acted on by external physical phenomena. In the cases of anthers, dehiscence is produced partly by pressure of the pollen grains on the coats of the anther-lobes, causing partial absorption of the latter, partly by special action of the fibrous cells lining the anther.

The main causes, however, of this class of movements are two: varying power of imbibition of moisture, and varying degree of elasticity in the tissues. These again are effected by the hygroscopic condition of the atmosphere; nowhere is this better seen than in the elaters of *Equisetum*, where, first of all, the spore-case splits at the proper time, and then the individual spores, whose *outer* coat has furnished (by splitting in narrow strips, which become detached) the said organs, uncoil their club-shaped elaters, which, acted on by the moisture of the air, assist in the carrying of the spores. Power of imbibition varies greatly, the degree of expansion of cells due to this varying from one-thousandth to one-half of the cell-diameter.

Expansion due to turgidity varies through a smaller range than that due to simple imbibition, the range being only from one-eightieth to one-fifth of the diameter of any cell. If unequal absorption of moisture takes place in various parts, distortion or curvature comes about and often permanent rupture. Moreover, if different degrees of elasticity should ensue, the equilibrium of turgidity is still more displaced. These, together with the well-known contractile powers of protoplasm and its power of motion from cell to cell, will probably account for most of these movements.

The dehiscence of seed-capsules or Fruits, be it valvular (that is, longitudinal), or by pores, as in Poppy, or by a circular slit, the top

coming off like a cap, as in Pimpernel, or by genuine valves, or uplifting flaps, is in all cases governed by the same physical forces, where also the varying anatomical structure of the several layers bears a part. Examples are seen in the twisting of the awns of Oat and other grasses, in the separation of the fruit-valves of Wallflower, Geranium, Spurge, and perhaps most notably in the capsules of the Balsam, *Impatiens-Noli-me-tangere*, taking its name from the fact that when ripe, you have only to gently press the middle of the capsule, when it suddenly coils up from each end, the middle part rises into a hump, and the seeds are shot out, as I have seen them often, to a distance of six or seven yards.

We will now pass on to the third and the most interesting class, where we find ourselves surrounded by phenomena at once wondrous, varied, and beautiful in their complexity and adaptation to useful end and purpose.

CLASS III.

Movements occurring in Living Parts of Plants during Active Growth.

We are confronted at the outset with an almost insuperable difficulty, *viz.*, the classification of such movements. After trying three or four systems, I have selected the following as, on the whole, best suited to my purpose in a paper such as this; it is to group them under two heads: *Periodic*—*i.e.*, occurring at regular times and under constantly similar circumstances; and *Induced*--*i.e.*, brought about by, for the most part, mechanical stimuli, such, for instance, as touch, concussion, etc., not simply by heat or light.

Under both these divisions we come upon instances where external influences *are* brought into play, and instances where, seemingly, it is *not* so. The two divisions, however, merge into each other almost insensibly, and many instances would fairly come under both heads, as we shall see. Others are with difficulty localised under either, as, for example, the constant movement all through life of some roots and stems. I can only lay before you a selection in each division, and only briefly touch on even these.

A.—Periodic Movements.

The morphology both of this movement and the Induced kind, consists for the most part of a folding up, or *curvature* of

some sort. We also usually find either some peculiarity in *tissue-construction*, or in the *union* of the moving organ to some other organ, such as the stem, etc.

Heat and light usually play a very important part in Periodic movements; for example, in the *Mimosa*, or Sensitive plant, movement is not seen at a temperature under 15° C, while death occurs if we get above 52° C. Prolonged darkness causes rigidity, and therefore loss of motile power.

As the most notable kind of Periodic movement we may take the so-called *Sleep* of plants, or of plant-organs.

I.—*Sleep of Leaves*. *Mimosa*, or Sensitive Plant. This leaf is bi-pinnate, *i.e.*, the compound leaf is divided into four *pinnæ* or leaflets, arranged like the sprays of a feather on the main axis, and again, each pinna is divided into a series of *pinnules* similarly situated. At night the pinnules fold *upwards* on one another all along the axis, like butterfly-wings: the pinnæ—*i.e.*, the four leaflets move *up* and *laterally*, closing over one another like the flaps of a fan; then the whole leaf-stalk bends downwards, getting closer to the stem. In fact, a steady but general collapse takes place.

These movements are effected, Darwin shows us, in two different ways: first, by *alternately increased growth* on the *opposite* sides of the leaf, leaflet, or leaf-stalk, as the case may be, the alternation usually being in the stalk at some part or other; this increase of growth on one side, or on the other, is preceded by an *increase in the turgescence* of their cells; secondly (and in our specimen probably, except in the very young plant, the only method), by means of an aggregated mass of cells called a *pulvinus*. The cells of this pulvinus have no chlorophyll, and form a little lump or swelling at the *articulation of the leaf-stalk with the parent stem*, consisting of a vascular bundle wrapped round with soft parenchymatous tissue; they exist also at the articulations of the leaflets with the common leaf-stalk, and there is a separate one for each pinnule, or ultimate leaflet, where it joins its common axis; the swellings here are called *strumæ*.

These swellings act as follows: the parenchymatous cells, which are the *irritable* ones, fill with water drawn from the plant; their cell-*walls* are not *irritable*, but they are *elastic*. Let the cells be irritated by a touch, or by concussion, or by degree of light or

heat, their contained water passes out from them, their turgescense is lessened, and their elastic cell-walls contract, the contraction affecting the side of the whole mass on the *touched* side of the pulvinus; the result is that the contraction of the touched side is communicated to the stalk, and it is moved up or down, as the case may be. In *Mimosa*, both at the main joint and the secondary ones, it is the *under* surface of the pulvinus which is irritable. You may touch the *upper* side and no result follows; but the *strumæ* are irritable only at the *upper* part. Hence, if the *under* side of the pulvini be touched, the leaf-stalk and the scondary stalk fall *down*, depressing the leaf *as a whole*; but the *upper side* of the strumæ being touched induces an *upward* movement of the ultimate leaflets, causing them to fold on one another.

Touch a struma at the *tip* of a leaflet, and the folding of the leaflets goes from tip to stalk-joint, the closing of one pair being sufficient to communicate the disposition to close to the neighbouring pair, this to the next and so on. Hence, if the lowermost pair be made to close, the impulse travels from joint to tip, by the same sympathetic influence. The movement is not hindered by the vascular-bundles inside the pulvinus, owing to their being extremely flexible. After depression has ensued, a fresh flow takes place of water into the emptied cells, turgescence sets in afresh, the leaf is raised, and the leaflets open again.

All this is effected periodically in the Mimosa by the light and heat of the atmosphere, which are the *stimuli;* the sleep commences just before sunset, the waking precedes the sunrise. So you see the Mimosa *closes* its leaflets and *drops* its leaves gradually during the day, and during the night is gradually *raising* the leaves and *opening* the leaflets, whereas many sensitive plants raise their leaves by day and droop them by night. Understand, the sleep is not comparable to that of animals, there being no relaxation, but the rigidity of tissues is persistent, although the organs may be in different positions.

One thing more. *Mimosa* shows a curious tendency on a succession of mechanical shakings of getting used to it. *Desfontaines* proved this experimentally by carrying a *Mimosa* on a stagecoach journey, when after a time, although at first affected by the jolting, the plant showed an admirable indifference to the inconve-

nient series of shakes, and bravely kept its leaves extended in spite of them.

Anyone who wishes to see the *poetical* side of this phenomenon cannot do better than read Shelley's exquisite poem, entitled 'The Sensitive Plant.'

Another wonderful instance of this curious movement is afforded by the Telegraph-plant, *Desmodium gyrans.* It is a trifoliate leaf, the terminal leaflet being very large, the lateral leaflets very small (in this species). During the day the end leaflet gradually follows the setting of the sun, sinking slowly until its under surface lies quite back against its own stalk, or petiole. The pair of side leaflets, on the other hand, are perpetually moving up and down with a jerky motion all day long, and in experiments on the plant it has been ascertained that this goes on until between 3 and 4 a.m., and commences again about 8.30 a.m.

Both the end and lateral leaflets move in virtue of *pulvini* at the base of their petioles. The end one would seem to be influenced by the sun in some way, but the lateral leaflets seem to be quite independent of external influences of all kinds. Their movements are not absolutely perpetual, but in spasms, stopping now and then as if to overcome some unseen obstacle. The motile condition (but not the movements) seems dependent on degrees of heat, light, and presence of water. The movements themselves appear to result from the alternate lengthening and shortening of one side of the petiole. Their motion is on their own axis, being circular as well as up and down, and each moves alternately with the other, the down stroke being rapid, the up stroke much more steady. It is called the Telegraph-plant, from the motion resembling the movements of the two arms of the old-fashioned Semaphore-signal. One curious fact remains to be noted; *viz.*, that as the terminal leaflet falls, its *petiole* rises, so that at night the *leaves* are all drooping and the *petioles* upright, thus greatly reducing the diameter of the plant.

There can be no doubt, that, in all instances, this sleep of leaves is brought about in order *to expose less of their surfaces to the effect of chill by radiation from those surfaces at night.* Hence, they assemble themselves together as closely as they can, and nowhere is this more beautifully seen than in *Desmodium*, where the rising of

the petioles of course very greatly assists to this end, while the vertical position of the leaves themselves acts in a like direction. In many plants exposed to a clear sky on a frosty night, this alteration of position means simply life or death. Darwin by many beautiful experiments has conclusively proved this.

Many other instances of the periodic movements of leaves might be here adduced, had I space. From the age of Pliny, who first noticed it, down to the time when Linnæus wrote his *Somnus plantarum*, the list of known cases has been increasing, and is destined to increase. If some few enterprising seekers after fact and truth could arrange a series of all-night watches between them on different trees and plants, I have no doubt many would be added to the list. We find one rule pretty generally operating; it is this: that plants that sleep do not get a good night's rest unless they have been exposed to a proper degree of temperature the day before, the degree varying of course in nearly every case. The leaves of French Bean sleep better in full summer than in early summer. A violent wind-shaking will sometimes keep species of *Maranta* (Arrow-root) awake for two nights in succession. Among a perfect host of plants whose leaves sleep, we may just name the following: Stitchwort, Mallow, Flax, Wood-Sorrel, Balsam, *Tropæolum*, Lupine, Clovers, *Lotus*, Acacias, *Wistaria*, Milk-vetch, and many *Leguminosæ;* Evening Primrose (*Œnothera*), Passion-flower, Tobacco-plant, *Polygonum*, Goosefoot, Spurge, Arrowroot, and only one among Cryptogams, namely *Marsilea* or Pepperwort.

II.—*Sleep of Flowers.* The 'Floral Clock' of good old Linnæus was a happy idea, but it must be taken *cum grano*, because a dull day or a bright one, a dry morning or a moist one will often modify the accuracy of the statements. Still, there is no doubt that certain flowers have a tendency, in many cases very pronounced, to open and close at specific times, or within a few minutes of those times.

A sufficiently accurate idea of these times may be gained from the following list, made out by Linnæus, but abbreviated by De Candolle, who confirmed each instance:—

Purple Convolvulus	... ...	opens at 2 a.m.
Great Bindweed	... ...	„ „ 3—4 a.m.
Chicory	... ...	„ „ 5 „

Dandelion, Nipplewort, and Blue Convolvulus	opens at	5—6 a.m.
Water Lilies	" "	7 "
Scarlet Pimpernel	" "	8 "
Marigold	" "	9 "
Red Sandwort	" "	9—10 "
Star of Bethlehem	" "	11 "
Blue Passion-flower	" "	noon
Pyrethrum	" "	2 p.m.
Night-flowering Catch-fly ...	" "	5—6 "
Evening Primrose	" "	6 "
Evening Campion	" "	7 "
Night-flowering *Cereus* ...	" "	7—8 "

Then, some flowers *close* at certain hours. Of these, just two or three suffice. Goatsbeard closes at noon. Hence, the name given to it by the dwellers on the Wye, of 'John Go-to-bed-at-noon.' You seldom or never see this vary outside the limits of 11.45 and 12.15.

Pimpernel	closes at	3 p.m.
Marigold	" "	4—5 "
Yellow-wort	" "	5 "
Daisy	towards sunset	

Those opening at 6 p.m. or later, are really *night-flowering* plants, and to make up for being unable to show their colours they are all fragrant to a high degree, and so attract the night-moths as their fertilizers.

Some flowers, such as the Red Sandwort, just named, close instantly on being plucked; others once opened remain open until they wither, as do most Orchids. Others, like the Commercial Flax (*Linum*), close a few hours after expanding, never to open again.

Some vary in their time of expansion. Water-lily remains open for twelve hours; Purslane closes after an hour's expansion at noon.

All these movements depend not on the *Direction*, but on the *Intensity* of light; it is needful to mark this, as will be seen. The Mechanism of the movements is not so well known as that of the

movements of leaves, but probably has to do with the contractile power of protoplasm in the *attached parts* of their organs, and with variation in turgescence.

Moisture has to do with some floral movements in what are called Hygroscopic plants, and so we can predict meteorological changes often with tolerable accuracy. The Siberian Sow-thistle closes at night if the following day is going to be fine, and the reverse. Bindweed, Marigold, and Pimpernel, if open, close on the approach of rain. Many leaves are hygrometric, as are also some larger *Algæ*, giving similar indications. Of these flowers, Pimpernel is most reliable, keeping its petals closed if clouds are coming or come; open if a fine clear day is at hand. This flower is called 'Poor Man's Weather-glass.' It is not only a very economical barometer, but a very sure one, which is more than we can say of some of those costing £20, or so; if Pimpernel be wide open at 9 a.m., you may leave coat and umbrella in your hall with almost perfect safety.

The time of year at which flowers open has to do with *Intensity* of light, and fairly comes under our present head; we are so accustomed to regard it as a matter of course, that Daffodil opens in March or April, Rose in June, Borage in July, Tansy in August, and so on, that we are apt to lose sight of the 'why' of the facts. The 'why' lies in the amount of light needed to stir their opening mechanism, the amount needed for them to do their work, and the amount they can bear, so to speak, as also of heat. Plants forming their floral-buds in the Autumn, and opening next Spring, are usually short-flowered; those budding and expanding in the same year usually remain open much longer.

So it is with *Geographical differences.* A plant opening at 6 a.m. in Senegal does not open here until 8 or 9 a.m., and in Sweden not until 10 a.m. One opening in Senegal at 10, opens here at noon, and not at all in Sweden; one opening at noon in Senegal will not bloom either here or in Sweden! So plants existing, say at Smyrna, Berlin, and Stockholm, flower in February, April, and June respectively. Along these same lines are the 'forced' plants, as we call them, acted on by artificially increased light and heat, as in the cases of Hot-house and Stove plants, and those grown in electric light.

Our last instance of Periodic or regular motion shall be taken from the phenomenon known as *Heliotropism*, or turning either towards or away from the light.

Positive Heliotropism, or turning towards the sun, is common enough, and is seen in the internodes of growing stems, in petioles, and peduncles or flower stalks. Here, the part turned to the light—*i.e.*, the *concave* side—is retarded in growth ; the *convex* side—or part turned away from the light—grows more rapidly, a remarkable case of inequality of growth. Among flowers, the *Compositæ* furnish us with many examples, one being specially prominent—the Sun-flower—whose peduncle twists in a circle during the day, bringing its flower constantly *towards the sun.* In the old Roman mythology, *Clytie* is made to follow *Sol* wherever he goes, in the form of a flower called *Heliotropium.* We do not know what this was. It was not our Heliotrope, because Ovid says it resembles a violet in its form ; it was not our Sunflower, since this was a native of America only, and, therefore, unknown to the Roman writer. *Ripening Corn* inclines to the South, not to the North.

Negative Heliotropism—i.e., turning away from the light—is a rarer phenomenon, reversing the above process, the part exposed to the sun growing more rapidly, and therefore being *convex*, the *concave* side being turned away from the sun. Cases are seen in the older branches of the Ivy-plant, and in Vine-tendrils, by means of which process these are enabled to cling to their support ; also, in the tendrils of *Bignonia*, the flower stalks of *Cyclamen*, and the plasmodia, or moving masses of *Æthalium.* In *Cyclamen*, it enables the plant to scoop a hole with its peduncle in the earth, or sand, and bury its own seed-pods.

One example, although not truly heliotropal, I cannot omit. The Compass-plant of the Texan and other prairies quite invariably grows with the *edges* of its leaves North and South, the faces or *surfaces* being East and West. This is done in order to expose *both* surfaces to an *equal* amount of light, there being in this plant an equal number of *stomata* on both surfaces.

The trappers use this plant as a compass on dark nights to find their way by, so true is it to its purpose ; and very wonderful is this provision for those who may be even in the daytime lost on the prairies. Mayne Reid, Burton, Lieut. Albert, the Prince of

Wales, and others testify to this. Sir J. W. Hooker says, that in railway-journeys through these parts, we can tell at once any change in direction by noting the position of these leaves.

> " Look at this delicate plant, that lifts its head from the meadow,
> See how its leaves all point to the north, as true as the magnet;
> It is the compass-flower, that the hand of God has suspended
> Here on its fragile-stalk, to direct the traveller's journey
> Over the sea-like, pathless, limitless waste of the desert."

Thus does Longfellow in 'Evangeline,' tell us in poetry, of a beautiful fact in nature !

I need scarcely say, that the sleep of the flowers is, like that of leaves, a provision for securing them from the ill effects of too great radiation, and that the *Direction*, and not the *Intensity*, of light is that which governs both positive and negative Heliotropism.

I have no space left to speak of *Positive* and *Negative Geotropism*, directing most stems upwards or away from the earth in the latter, and roots downwards and to the earth in the former, nor of the effects of positive Geotropism in securing a decent and useful burial for the pods of subterranean Clover, and some other flowers.

Our second division of Class III—*viz.*—

B.—Induced Movements—*i.e.*, those brought about by mechanical stimuli, and in no way Periodic—I must also leave untouched.

I can only indicate briefly what this division includes by referring to—

I.—*Induced Movements in Leaves*, such as may be seen in *Mimosa* and *Desmodium* (already noted as also illustrating Periodic motion), and in Sundew and Venus' Fly-trap (*Dionœa*), where insects are the agents, sacrificing their own lives in the process. Also to such cases as the leaves of *Schinus* and *Rhus*, which can be made to execute a literal dance by throwing them into water. In *Utricularia*, or Bladderwort, the fine, hair-like leaves are furnished with floating bladders; these possess valves which close with a certain and fatal snap when the wanderings of aquatic

insects, or the restless, prying curiosity of young fishes, lead them to touch the bladders.

II.—*Induced Movements in Floral-Organs*, seen in the irritability of stamens in Barberry, Pellitory, Nettle, Saxifrage, Rue, Grass of Parnassus, Periwinkle, etc. ; in the movements of the styles of Passion-flower, Cactuses, and others; in the mutual approach of stamens and styles in *Onagraceæ* (Fuchsia), etc., and the Mallows; in the raising and lowering of the *labellum* of many orchids, and the central parts of the same flowers.

All these cases except the last and those of the Leaves have to do with fertilizing processes; those of the leaves of *Drosera* and *Dionæa*, and of the bladders of *Utricularia* with the actual nutrition of the plant.

Of Climbing Plants I will, if opportunity offer, write at some other time, and try to show the meaning of twiners, root-climbers, hook-climbers, leaf-climbers, and tendril-bearers.

Sutton, Surrey; April, 1885.

Grosse's Classification and Structure of the Bird-Lice or Mallophaga.*

ABSTRACT BY PROFESSOR G. MACLOSKIE.

(For the *American Naturalist.)*

PLATE 20.

THE MALLOPHAGA, or bird-lice, are wingless insects with incomplete metamorphosis, mandibulate mouth-parts, two or three-segmented thorax, eight to ten abdominal somites. They live on mammals and birds, feeding on their scales, hairs, and feathers. The genera which are found on mammals never occur on birds, and *vice versa*. Redi first observed (1688) that there are some lice with haustellate and others with mandibulate mouth-parts. Nitsch (1842) carefully examined them, and Von Giebel (1874) improved on his work.

* Beiträge zur Kenntniss der Mallophaga, von Dr. Franz Grosse in Strassburg. Zeitschrift für wissenschaftliche Zoologie, Bd. XLII., pp. 530—558, mit Taf. XVIII. (1885).

Nitsch divides them into two chief groups—PHILOPTERIDÆ and LIOTHEIDÆ. The Philopteridæ have filamentous antennæ and no palps: the Liotheidæ have clavate four-jointed antennæ and palps. The Philopteridæ comprise two families: (1) TRICHODECTES, the only genus, characterized by three-jointed antennæ and one-clawed feet; (2) PHILOPTERIDÆ, *strictè*, with five-jointed antennæ and two-clawed feet.

The LIOTHEIDÆ have likewise two families: (1) GYROPUS, the only genus having one-clawed feet; and (2) LIOTHEIDÆ, *strictè*, with two-clawed feet.

TRICHODECTES and GYROPUS occur only on mammals, the other genera only on birds, and are classified according to the presence or absence of appendages on the head (trabeculæ) and their motility, to the sexual differentiation of antennæ, their attitude, the form of the head, the consistency of the thoracal somites, and the form of the last abdominal somites.

PHILOPTERIDÆ, *strictè*.

1. Trabeculæ motile, antennæ nearly alike in both sexes ... ... *Docophorus*.
2. Trabeculæ not motile.
   - *a*. Antennæ filiform, no sexual differentiation.
     - (*a*) Hind-head rounded off, terminal somite of male rounded off ... *Nirmus*.
     - (*b*) Hind-head abruptly angled, abdominal somites fused in the middle *Goniocotes*.
   - *b*. Antennæ of male forcipate by a process from the third segment.
     - (*a*) Hind-head angled, terminal somite of female tubercle-like, of male rounded off ... ... *Goniodes*.
     - (*b*) Hind-head rounded off, terminal somite of male notched ... *Lipeurus*.

LIOTHEIDÆ, *strictè*.

1. Mesothorax wanting, antennæ generally concealed.
   - *a*. Head very broad, no orbital sinus ... *Eureum*.
   - *b*. Head elongated, with lateral angles directed backwards.

(*a*) With sharply marked-off clypeus and shallow orbital sinus ... *Læmobothrium.*

(*b*) With only wavy head-margins, and long lateral lobes on the labrum... *Physostomum.*

2. Mesothorax present.

a. Mesothorax large, sharply marked-off, head three-sided, antennæ concealed *Trinotum.*

b. Mesothorax small, only indicated.

(*a*) Orbital bay deep, antennæ mostly elongated and visible ... *Colpocephalum.*

(*b*) Orbital bay very shallow or obsolete, antennæ concealed ... *Menopon.*

Grosse's researches have been largely on a Liotheid found on a pelican from Chili, closely related to *Menopon*, and forming the type of a new genus and species, *Tetrophthalmus chilensis.* The male is 4—4½mm long, the female slightly less. He also contributes important emendations of our knowledge of the other species.

Head.—In *Tetrophthalmus* the head is somewhat constricted, is broader than long, slightly convex above, concave below, and somewhat uniform, the occipital angles being rounded off. The hinder limit of the clypeus shows on each side a notch, about a third from the front of the head; two dark spots are seen on each side of the head, the larger one near the notch, the other behind it and outwards. The antennæ lie concealed in a lateral cavity of the under side of the head (as in *Læmobothrium*, Pl. XX., Fig. 1, *at*). Two eyes, whose pigment is seen from above, lie on each side below and behind the antennal cavity. Hairs are distributed over the head, along the borders, and on its ventral and dorsal surfaces. On the under-side of the head is the funnel-shaped mouth-opening, surrounded by the mandibulate mouth-parts. Grosse describes the mouth-parts of MALLOPHAGA in detail, as previous writers err greatly regarding them.

Labrum (oberlippe).—This is not, as in other insects, inserted on the anterior border of the head, but in all Mallophaga it is on the under side of the head. In all LIOTHEIDÆ it is similarly formed (Fig. 1, *lb.*), being a thin transverse arched swelling, with

chitinous margins bearing small bristles. The labrum of the *Philopteridæ* has a broad disc-like basis fixed on the under side of the head, and is divided by some transverse furrows (Figs. 2, 3, 5, *lb.*) There is a broad furrow, separated from the mouth by a plate of chitin, and farther forward a deep narrow furrow, next the anterior boundary of the labrum. In the living animal the labrum is constantly moving; and in PHILOPTERIDÆ it can adhere to glass like a suctorial disc. The labrum can thus hold on to hairs or feathers.

Mandibles.—As a type, we take the mandibles of *Tetrophthalmus* (Fig. 4). They have each two strong, long teeth, somewhat different in their structure.

The under tooth of the left mandible has a protuberance with curved point and an arched surface; its upper tooth has two points. The right mandible has two stout teeth, which fit the left mandible on closing. This serves for cutting particles held between the labrum and the first maxillæ. The large pointed teeth serve for removing dermal scales. The mandibles of the PHILOPTERIDÆ are long, triangular, and two-toothed, the teeth short and thick (especially in genus Docophorus).

First maxillæ.—These are conical, and have a basal and a terminal segment or blade, distinguishable in young specimens. The inner side of the blade has hooklets (not in *Docophorus*), (Figs. 5, 6). The maxillæ seem to take no part in comminuting the food beyond aiding in its prehension. With all care Grosse has never been able to find the palps of the first maxillæ which Nitsch ascribes to LIOTHEIDÆ. Nitsch figures them in *Trinotum conspurcatum*, but this can scarcely be correct, for he places the four-jointed papillæ on the blade near its anterior border. In *Tetrophthalmus* the palps belong not to the first but to the second maxillæ. The same is true of *Menopon pallidum*, *Colpocephalum zebra*, a Læmobothrium from *Gypogeranus serpentarius*, and a Trinotum from the swift, and probably is the case with all the genera and species.

Second maxillæ (unterlippe).—These are flat, fused, bounding the mouth posteriorly. They consist, in LIOTHEIDÆ, of two parts, which are united by a transverse fold (Fig. 8). The basal part (mentum, *mt.*) represents the coalescing stipites and squamæ of

normal first maxillæ, and bears the four-jointed labial palps. The upper part is the ligula or glossa (*g.*), corresponding to the inner blade (lacinia). Laterally on the ligula are the paraglossæ (*p.*), corresponding to the outer blade (galea). A chitinous band limits the glossa where it bears the paraglossa, as if the parts of both had coalesced.

Rudow seems to have mistaken the antennæ for the labial palps. Melnikow overlooked the labium, and erroneously compared the products of the œsophageal intima with the proboscis of Pediculina, in consequence of this false comparison referring the Mallophaga to Rhynchota.

The labium of the PHILOPTERIDÆ has no palps (Figs. 7). It is usually triangular, with rounded angles, and is sometimes very small, as in the genus Lipeurus, the mentum being smaller than the ligule. The ligule is emarginated in *Docophorus* and *Lipeurus.* The paraglossæ of PHILOPTERIDÆ, as in the LIOTHEIDÆ, are like tactile organs, remarkably long in species of *Goniodes.*

In all LIOTHEIDÆ the intima of the ventral end of the oral cavity forms a fold-like duplicature as in PHILOPTERIDÆ (hypopharynx, Fig. 2, *hy.*). In *Læmobothrium* and *Tetrophthalmus* this extends forward over the labium, and its lateral borders are strongly bent upwards (Figs. 1, 8, *hy.*).

For the study of the head Grosse made transverse and saggital sections of specimens fresh from moulting and hardened in chromic or picric acid. From absolute alcohol they were placed in chloroform, and after two hours embedded in paraffin, being kept for a time in melted paraffin under the air-pump. The sections were attached to the slide by means of albumen or oil of cloves, stained by alcoholic carmine-solution, treated with acidulated alcohol so as to show the nuclei, and then enclosed in Canada balsam.

Thorax.—In the genera *Trinotum*, *Colpocephalum*, and *Tetrophthalmus*, the three thoracic somites are present, especially manifest in the young. The prothorax of *Tetrophthalmus* has above a rounded swelling, and ends forwards in a bristly point on each side. Within the prothorax, but visible through the transparent dorsum, is a cross-band of chitin, as in *Menopon*, for the attachment of muscles. The mesothorax is much narrower than the

other thoracic somites. The metathorax is of trapezoidal form, and much broader and shorter than the prothorax. The borders of these somites are strongly chitinised. There are no wings or rudiments of wings. The foremost of the three pairs of limbs are the shortest, and they act as foot-jaws, drawing fragments of food to the mouth. In the male *Tetrophthalmus* they are large, and also serve for holding the female. The tibia of all the limbs of the male have their inferior end extending into a knob with sharp processes like a "morning star." There are only two tarsal joints, the distal one being the longer and bearing two incurved claws, inclosing between them a soft lobe (pulvillus). The bristles on the tibia and the "morning-star" processes of the male serve for holding the female, which indeed often clambers among the feathers of the host.

Abdomen.—The female of *Tetrophthalmus* has ten abdominal somites, the terminal one soft and rounded. The male has nine, as the last is invaginated so as to serve as a sheath for the penis; the hind end of the male is pointed and more chitinised, and more darkly coloured than in the female.

Digestive track.—Two types of crop are found in the MALLOPHAGA. In PHILOPTERIDÆ the crop is a lateral diverticulum of the œsophagus; in LIOTHEIDÆ it is a club-shaped symmetrical enlargement of the œsophagus. Kramer divides the intestine of *Lipeurus* into an oral cavity, an œsophagus, crop, chylus-stomach, and hind-intestine. The œsophagus reaches back to the abdomen, and has a homogeneous chitinous intima. The intima of the crop has spines, and its cells appear to secrete a fluid. The chylus-stomach extends to the entrance of the malpighian tubules. Grosse finds in the œsophagus of *Tetrophthalmus*, behind the hypopharynx, a chitin bar produced by thickening of the intima, consisting of a groove-like mid-piece, and running forward and backward into two diverging branches. The hind branches have muscles from the occipital border of the cranium. These chitinous bars are not haustellate, but support the oral intima, and in their groove are sent along comminuted fragments of feathers, retained by the retrorse spines and denticulations of the dorsal part of the intima.

Goniodes has two squamous œsophagal pieces, a dorsal and a

ventral (Fig. 2, *ds.*, *vs.*). The ventral piece has posterior processes joined by muscles with the occipital border. The dorsal piece sends forward a muscular bundle, which bifurcates, and its divi sions are inserted on the anterior cranial border. Two ducts (probably salivary) run forwards through these scale-like pieces, uniting into one. The chylus-stomach is cordate at its beginning, and has no chitinous intima. The hind intestine has six longitudinal grooves and rectal glands, with richly branching tracheæ and a chitinous intima.

The mode of nutrition of MALLOPHAGA is not fully ascertained. Nitsch stated that they eat the epidermal products of birds and mammals, and sometimes blood. Grosse finds that blood is rarely taken, and only in cases where the bearers (birds) are so injured or diseased as to have blood among their plumage; and Leuckart gives the same result as to *Trichodectes canis* of the dog. In *Læmobothrium*, Grosse found the intestine filled with the limbs of its own kind, as if it ate the product of its own moulting.

Malpighian vessels.—These are four, not branched; have a lumen, and ganglion-cells (not separated from the lumen by any membrane).

Salivary glands.—There are two pairs; and exceptionally the PHILOPTERIDÆ have one-celled glands as on the crop. Grosse found one of these cells undergoing division. The salivary organs include salivary glands and salivary reservoirs. The glands usually adjoin the crop or stomach, and have a cell-layer with nuclei, covered externally and internally by a fine homogeneous epithelium. Before the entrance of thin ducts into the œsophagus, a gland and a salivary vessel unite into a common duct.

Sexual organs.—The male sexual organs are of the usual type of insects, paired testes, spermatic ducts, a seminal vesicle, ejaculatory duct and penis. Nerves supply the seminal vesicle and ejaculatory duct; and in *Tetrophthalmus* the terminal somite of the abdomen is withdrawn so as to be concealed, serving as a sheath for the penis. The female organs consist of paired ovaries (three pairs of ovarian tubes in LIOTHEIDÆ, five pairs in PHILOPTERIDÆ), two oviducts uniting into one and a seminal receptacle. The egg-case has a lid which springs open at the exit of the young insect.

Respiratory apparatus.—There are seven pairs of stigmas: one in the prothorax and six abdominal. Each stigma has internally a crown of fine hairs to protect from impurities. A pair of strong longitudinal tracheæ send branches to the stigmata and are united to each other by a strong cross branch in the abdomen, and smaller ones in the head and thorax.

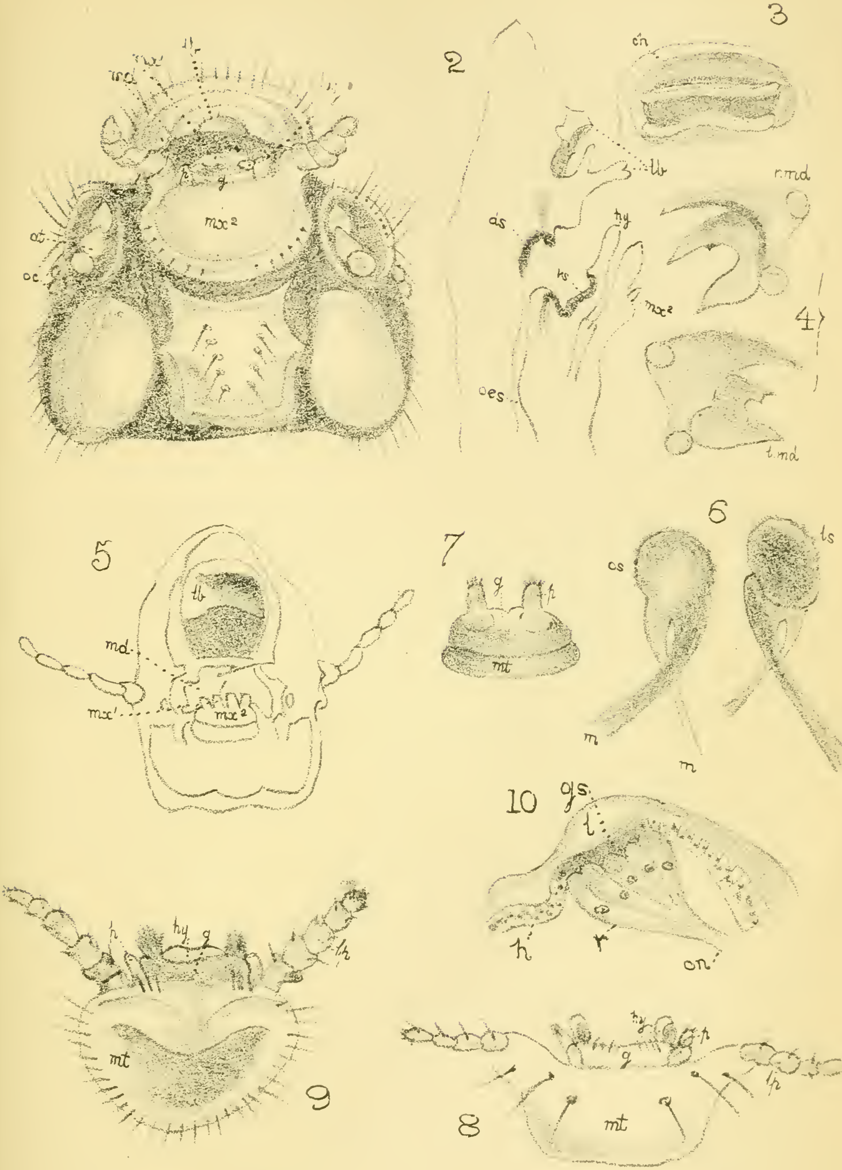
Dorsal vessel.—Grosse could not succeed in making a preparation of this, but in the recently-moulted living animal it can be seen pulsating through the back.

Nervous system.—This consists (in PHILOPTERIDÆ) of two cephalic ganglia and three thoracic ganglia. The preœsophageal ganglion is much larger than the subœsophageal, and they are united by strong commisures. The last thoracal ganglion is large, and sends back nerves to supply the abdomen.

Antennæ.—In LIOTHEIDÆ these are four-segmented, club-shaped or knobbed, the terminal segment spherical, lying in a hollow of the sub-terminal one (Fig. 1, *at*). In a cross-section of the terminal segment of *Læmobothrium* are seen round nucleated cells, apparently ganglionic enlargement of nerves. The Liotheidæ have the antennæ alike in both sexes, but in PHILOPTERIDÆ the third segment of the antennæ of the male has a lateral process, sometimes so large as to make the antenna resemble a lobster's claw. Nitsch states that it is for holding the female.

Eyes.—These lie on the margin of the under surface of the head behind the antennæ. Authors have hitherto ascribed a single pair of eyes to all Mallophaga. But in all Philopterid genera examined (*Goniodes*, *Docophorus*, *Lipeurus*, *Nirmus*) the author found a single pair, and in all Liotheid genera (*Tetrophthalmus*, *Læmobothrium*, *Menopon*, *Trinotum*, and *Colpocephalum*) he found two pairs of stemmata. If this character holds good for the remaining genera, it will still further separate the two chief divisions of the Mallophaga.

The eyes of Mallophaga are simple, provided with a lens-shaped thickening of the cuticle. In young specimens the eye has no pigment, but in older specimens it has pigmented retinal cells. The eye of *Læmobothrium*, examined by means of sections, has, under the chitin-thickening (Fig. 10, *l.*), twenty-four pigmented retinal cells (*r.*), clavate and nucleated with nucleoli,



Structure of the Mallophaga

merging gradually into the pigmented optic nerve (*o.n.*). Each eye is directly innervated from the preœsophageal ganglion. The hypodermal cells are interposed between the lens and the retinal-cells, as cubic cells in old specimens, but as a hyaline body consisting of cylindrical cells in young or recently-moulted specimens. There are no rhabdites in the eyes. The eyes of Mallophaga resemble those of *Phryganea grandis*, as described by Grenacher.

EXPLANATION OF PLATE XX.

Fig. 1.—Ventral view of head of *Læmobothrium*, from *Gypogeranus serpentarius*, × 30.

,, 2.—Median section through head of *Goniodes dissimilis*, × 60.

,, 3.—Labrum of *Goniodes dissimilis*, × 60.

,, 4.—Right and left Mandibles of *Tetrophthalmus*, × 60.

,, 5.—Head of *Lipeurus heterographus*, seen from below, × 60.

,, 6.—First maxillæ of *Tetrophthalmus*, × 75.

,, 7.—Second maxillæ of *Nirmus*, × 60.

,, 8.—Second maxillæ of *Tetrophthalmus Chilensis*, × 60.

,, 9.—Second maxillæ of *Læmobothrium*, × 60.

,, 10.—Eye of *Læmobothrium*, seen on cross-section of the head, × 190.

Explanation of reference letters in the figures :—

at., antennæ ; *ch.*, chitinous bar ; *d.s.*, *v.s.*, dorsal and ventral parts of œsophageal sclerites ; *g.*, glossa (ligula) ; *g.s.*, glassy body ; *h.* hypodermis ; *hy.*, hypopharynx ; *i.s.*, *o.s.*, inner and outer side of maxilla ; *l.*, lens-shaped chitinous thickening ; *lb.*, labrum (upper lip) ; *l.md.*, *r.md.*, left and right mandibles ; *l.p.*, labial palp ; *m.*, muscle ; *md.*, mandible ; *mt.*, mentum ; $mx.^1$, first maxillæ ; $mx.^2$, second maxillæ (labium, or under lip) ; *oc.*, eyes ; *œs.*, œsophagus ; *o.n.*, optic nerve ; *p.*, paraglossa ; *r.*, retinal cells.

On Making Useful Collections of Insects: A Plea for the More General Use of the Compound Microscope by Collectors.

By Robert Gillo.

THOSE who make collections of Insects ought to do so primarily for two reasons: first, to study their construction and habits; and secondly, to admire for themselves, and to be able to show their friends their marvellous beauty of form and colour. I say they *ought* to do so, because there are those who collect merely for the sake of making collections. To such individuals the pleasure of acquisition is paramount, and the consciousness of possessing and being able to say that they have so many species or specimens without hardly ever seeing them, and much less studying them in detail is their sole delight. It is true that the desire to make a collection may be, and in fact often is, the means of inducing an individual to commence the study, and when he sees the immense variety of form, colour, and wonderful modification and adaptation of the various parts, according to the requirements and habits of the insects, clearly showing a unity of design throughout the whole which he did not suspect, a genuine scientific interest is awakened in him which ultimately leads to good results.

How is it that there are so many collectors of British Butterflies and Moths, and so few who study any of the other orders of insects? I think it is not only because Butterflies are prettier objects superficially, of larger size and more showy appearance, but also because there is no difficulty in finding their names; whereas all other orders of insects are difficult to name correctly, owing to the immense number of species, superficial resemblance, absence of striking marks, and often their minute size, so that the only means to effect this is by patient study and comparison of small details; in fact, a thorough investigation of every external part of the insect. This, I suspect, is the real reason of so few workers in this field. Those who collect Lepidoptera only know nothing of the hours of close study often spent in attempting to satisfacto-

rily determine the name of a particularly minute insect. Of course, they do not experience the keen pleasure which is felt when, after a long search, it is beyond a doubt correctly named and classified.

The lepidopterist, to name his specimens, has often only to refer to an illustration, or sometimes to get a friend to name them for him; but even if he has to refer to a description for the purpose, the colours and markings are so striking and well distinguished, and the number of species so comparatively few, that it is a matter of little or no difficulty. It may be said that the very small moths—as, for example, the numerous family of the TINEINA—are difficult to make out, and doubtless such is the case; but here most collectors fail. The majority collect only the larger species, commonly called Macros, and altogether ignore the *Tortricini* and *Tineina*, or the Micros. This habit is so general that lists are published of the Macro-Lepidoptera only. These entomologists like the fun and excitement of collecting and showing these large and brilliantly-coloured insects, and expatiating on their beauty and rarity; but are found to be sadly wanting when required to make out the particular species of an insect, which can scarcely be seen with the naked eye, and is, superficially, so like dozens of other species, that it is only by an intimate knowledge of the whole that any particular one can be determined with certainty.

It may be urged that Butterflies are easier to obtain than other insects, and that this is the reason why they are so generally collected; but this, however, is not really the case, for not only is the season of collecting Lepidoptera more restricted, but the capturing and bringing home are much more difficult. In proof of this, when we speak of the insects of the entire world, or of those of any foreign country, the case is exactly reversed, for the greatest number of species collected and described have been of those insects which are easiest to obtain and to send home. Hence, the species of Beetles known and described far outnumber those of any other order of insects. Beetles can be easily preserved by being placed in spirit, in which they will keep any length of time and retain nearly their original brilliancy, and in this way one moderate-sized bottle will suffice to contain an immense number of specimens. Butterflies and Moths, on the other hand,

are, when caught and killed, not easily packed for transmission; the usual and, I believe, best plan being to wrap up each specimen in a triangular piece of paper and place them all in a box together. But this method is very unsatisfactory, the insects being liable to get rubbed, and only too often eaten up by mites before they are relaxed and reset at home.

There have been and are now genuine workers who have studied the Macro-Lepidoptera only. Some of these have not only collected many rare species, but have worked out the life-history of each by rearing the insects from the eggs, and have made accurate drawings and descriptions of the larvæ and pupæ. I need only mention the very beautiful and careful drawings of the larvæ and pupæ of the Lepidoptera made by the late Mr. W. Buckler, and of which those of the Butterflies have been published by the "Ray Society" as their annual volume for 1885. Again, the preserving specimens of the larvæ and placing them in the cabinet by the side of those of the perfect insects, has of late years been prosecuted by some energetic and enthusiastic collectors with great skill, one of the most successful of whom is Lord Walsingham, whose magnificent collection is said to be a treat to see. Another who has persevered in this line is Miss Golding-Bird. I may also mention that several ladies have distinguished themselves in rearing these insects through all their stages, and would more particularly name Mrs. Hutchison, of Leominster. Such earnest workers deserve the greatest praise, but compared with the number of collectors these genuine entomologists are very few.

I think one thing which prevents collectors from turning their attention to small insects—particularly beetles—and those even who do so from the more general study of their minute structure, is the want of a microscope. One of our very best authorities on Beetles says, "If you cannot determine the species of your insect with a pocket-lens, and a Stanhope or Coddington for the very small ones, give it up and take to collecting stamps or something similar." He, however, goes on to say, "If you want to study the structure of your insects, you must dissect them, and then a compound microscope is necessary." It is a fact that the majority of collectors do not possess a microscope; they simply

examine the insect with a pocket-magnifier, and if they can see a certain mark, spot, or peculiarity of form or colour, it is sufficient for them because it enables them to name it. They then place it in the collection, and there it remains. We are all liable to fall into this way of making collections, as there is a natural feeling of pleasure in filling up gaps and improving the general look of our cabinets.

Undoubtedly, the first and most important thing is to find out the name of any insect we may have, and it is of little use to study its habits and structure, unless it is ascertained beyond a doubt what the insect has been called by a particular author, or if it should be proved to be a new species, to describe it accurately, give it a name, and publish it with the description. Here is the great use of all the systems of classification, for without a system of nomenclature it would be impossible to name the thousands of species we meet with in such a way that would lead to anything but confusion.

Some popular books—no doubt, with the object of simplifying the study of insects and rendering it more attractive—write rather disparagingly of making collections of the numerous species, and, as they say, arranging them in rows in a cabinet. They argue that it is better to study their habits and life-history without troubling about their long and difficult Latin names ; but this is a fallacy, for no observations can be of any use unless it is known beyond a doubt to what insect they refer. For this purpose any popular or local name, even supposing the insect has one, is often worse than useless and sadly misleading. Most of the facts relating to insects recorded by ancient writers are, for this reason, of very little value, because it is a matter of considerable doubt to what insects they bore reference. Some naturalists even, from not attending to this important point, have rendered their observations, which would otherwise have been of great scientific value, of comparatively little real use.

A practical instance of this came under my notice recently. A gentleman living near where I reside asked me if I had a specimen of the "Hop-Dog" in my collection, because if I had not he could get for me as many as I might wish off the fruit-trees in his garden. This aroused my interest, as the larva of *Dasychira*

pudibunda, or Pale Tussock Moth, is called the Hop-Dog in the hop-growing districts; but for it to abound on fruit-trees in Bath was quite a new thing to me. A description which he gave me failed entirely to enable me to discover what the insect really was which he called the Hop-Dog, but I suspected it was not the larva of the Tussock Moth. Fortunately, it was possible for me to go to the garden and see the insect, when it turned out to be the larva of *Orgyia antiqua*, or the Vapourer Moth, which is very common everywhere, even in the metropolis. He, however, thought it was the Hop Dog, and that the wind had blown the eggs or the insects over from the hop-gardens of Kent! Now, suppose for a moment that he had published his own account either in a scientific or a local paper, how difficult, if not impossible, it would have been, in after years, to have discovered the real facts of the case!

I need not point out what a very superior and correct view of an insect is obtained when it is seen under a good binocular microscope, compared with that which it is possible to get by the use of the pocket-lens; but from the manner in which our cabinets are usually arranged, the specimens are not readily available to place under the microscope. They have to be removed from the cabinet, and, after examination, again replaced, this removal being in itself attended with some considerable risk, and consequently it is not likely to be often done. I was once shown a type collection of small beetles that had been arranged by a foreign professor. They were painfully exact and uniform. Each specimen was precisely the same height; the pins were placed perfectly upright and in straight rows. It was much admired by the gentleman who owned it for its supreme neatness and regularity; but he would not on any account allow a specimen to be touched because he was afraid he should not be able to replace it with the same regularity as before; hence the collection was useless, although the specimens were intended as types to determine doubtful species. I do not wish it to be understood that I advocate a slovenly arrangement of badly-set insects; on the contrary, I think the objects are so beautiful and interesting that a collection of them ought to be as neat and attractive in appearance as it is possible to make it. Nevertheless, I maintain that it may be laid down as an

axiom that the true use of a collection is for reference, and that that collection is the best which is the most useful.

Our collection should consist not only of specimens of each species, both male and female, exhibiting both the upper and under sides, but also any peculiar variation, and all those peculiarities of structure on which the genus is founded ought to be clearly shown, and the specimens should be in such a form as to be readily available for examination at any moment without our feeling that we are pulling our collection to pieces or incurring any risk of damaging our specimens. It is to point out how I think this end may be attained, and how a collection may be made which shall be useful as well as ornamental, that this paper has been written.

As I collect and study beetles only, it is about them in particular that I purpose speaking, but the same methods may be adopted with other insects with, perhaps, some slight modifications. In the first place, whatever plan or method we may adopt to render our collection useful for reference and the specimens easy of access, we must have a collection arranged in boxes or drawers in the usual way—that is, in order of classification, and with spaces for the whole of the known British species, so that we may place an insect in its proper position as soon as it is determined without shifting any other specimen. This plan obviously has its advantages; besides, the larger species could hardly be treated in any other manner. As I before pointed out, we ought to have male and female specimens of each species, exhibiting both the upper and under sides; and those insects which fly should be represented by at least one specimen of each sex, with wings extended; but in addition to this, I think, a dissection of some of the larger and typical species, so arranged as to clearly show every part of the external structure of the insects, would be of immense advantage. In fact, a reference collection can scarcely be considered complete without it, as we should then be able to ascertain the form and structure of any part, without, as is now usually done, taking a specimen and picking it to pieces, and thereby destroying it.

So far, it is very much on the lines usually carried out by all collectors, although I have seen some extensive collections in

which every specimen was placed in one position, showing only the upper side, and none with the wings extended. whilst the idea of placing a dissection in the cabinet was quite unthought of. The form of cabinet, and the method of mounting and arranging the specimens may be a matter of individual taste, but even here advantage may be gained by adopting a certain form of cabinet and a certain system of mounting. I am strongly in favour of using boxes in preference to drawers. They are more portable, and do not require the glass covers which all drawers containing insects must have. This in itself is a great advantage, for to examine any specimen from the drawers the glass top must be lifted out of its place. Again, if, when the collection was first arranged, sufficient space was not left, or it has since been thought desirable to add more specimens to illustrate peculiar varieties, the whole of the collection must be re-arranged, which in a thirty-drawer cabinet is such an undertaking as would scarcely be attempted, unless all the drawers are precisely alike, and therefore interchangeable, which is so rarely the case that practically we may say that it never is so. Whereas, if you use boxes, it is only necessary to introduce another box just as you would a book on your library shelf. The size of the boxes may be a matter of opinion. About ten by fifteen inches seems to be a very convenient one, but it is certainly a mistake to have very large boxes. They must, of course, all be of uniform size, and labelled and numbered distinctly on the outside.

This applies alike to all orders of insects, but now my remarks will more especially refer to Beetles. Coleopterists usually mount each individual specimen on a separate card, taking as much care as possible to have all those of one species on cards of uniform size. A pin is inserted at the foot of each card, which is pushed up to the head, so that by using pins of one size only all the specimens may be of one height. It is obvious that the only means of removing the specimens is by using a small bent pair of pincers. I prefer using cards about two inches long, and of a width suitable to the size of the insects, and placing on each card from two to six specimens. The size of the cards enables me to write on the under side the name of the species, locality, and any other information.

Those who use a separate card for each specimen adopt the plan of numbering each and keeping a book of reference. The objection to this method is that very soon the number of specimens becomes so enormous, and the entering in the reference-book takes so much time, that it is soon discontinued. One reason why separate cards are used is because it is often difficult to determine whether several specimens are really of the same species. They are, therefore, mounted singly, and put aside for consideration at some future time, whereas if they are to be associated together on the same card, this point must be decided at once. This is, I think, rather an advantage than a drawback, as these difficult points get cleared up at once instead of being put off and forgotten, and perhaps never properly worked out at all.

I now come to the points to which I feel many collectors would object. I think we ought also to have specimens mounted in such a form that they can be placed on the stage of the microscope at once, and at the same time to be so protected that they may not get injured by repeated handling and examination. This object, it seems to me, may be attained by mounting the insects on the usual three-by-one inch glass slips in a dry cell as solid objects. After trying various kinds of cells, I found nothing at that time better than cardboard, punched out with a gun-punch, and stuck on with gum-tragacanth, to which some drops of carbolic acid had been added. The cells were made of the required depth by building up, piece upon piece, as many thicknesses of card as were necessary, and when dry the inside of the cell was brushed over with benzole, containing about 10 per cent. of carbolic acid. The insects were placed in the cells, and attached with the smallest quantity of gum-tragacanth, and, if not too delicate, such as the green weevils, were lightly brushed over with benzole. This removes grease, which is a condition Beetles are very likely to assume, and effectually prevents the growth of fungi. The precaution was also taken, before putting on the cover-glasses, to place the slides in a moderately hot oven for a short time, so as to ensure their being quite dry. They were then covered with coloured paper in the usual way, and distinctly labelled, marking not only the name and locality of the specimen, but the peculiarity, if any, which the particular slide was intended

to show. The glass slips were of the commonest quality, selected thin and flat, and cut to the exact size. The edges were not ground, but the extreme sharpness was removed from them by dragging one edge over another, and if this is thoroughly done it is a very good substitute for ground and smoothed edges. I think the plan I have described better than metal, porcelain, or glass cells sealed up hermetically, as dry mounts often fail owing to imprisoned moisture. One may suppose that a cell of cardboard which is not perfectly air-tight would be best. However, be this as it may, I found all to go well for a time, but after some months I noticed some of the larger Beetles showing signs of the old enemy, *grease*. This, of course, was fatal, so I set to work to find another and I hoped a better way. I thought of a metal cell, with a cover which could be removed when viewing the object; in fact, something like a small, shallow box with a lid to it. The next thing was to see if such a cell could be obtained, and I found that it would in the first place be necessary to have special dies made. The cost, however, of these was such that it was quite out of the question. Then I thought of pill-boxes, and I think I have secured all the advantages wished for in a very simple way, by merely affixing a pill-box of one inch in diameter of the kind known as "Frank's Postal Pill-Boxes" on the centre of a slip of glass, which has been previously papered; and to prevent particles of paper being frayed off and getting on the objects, the pill-boxes were brushed over inside and out with shellac varnish or patent knotting. This very much strengthens them and improves them in every way. The plan of varnishing all pill-boxes used for collecting purposes is a very good one, as they then last very much longer and are not readily affected by damp. Mounted in this way, the objects can be readily treated with the proper remedies if anything goes wrong with them, and there is not the interference of the cover-glass, which is an important consideration, if it is wished to view the object at all obliquely.

Of all the larger species, dissections of the mouth-organs may be easily made and mounted in this way. Dissections will not be required of every species, but only of those typical of the genera, or that show any striking peculiarity. The very large insects

cannot, of course, be mounted in these boxes entire, but they are few in number, and parts of them exhibiting all their characteristics may be readily preserved, and be of every use, whilst the entire insects would be kept elsewhere in the usual cabinets.

There is another plan which has many advantages—namely, using the largest-size homœopathic pillule tubes (not bottles), and mounting the insects on strips of card the length and width of the inside of the tube. These strips are attached to the corks by being pushed into a cut made with a penknife, so that the card is not only kept in position in the tube, but on taking out the cork, the strip of card with the insects on it comes out also, and in a way convenient for viewing. The genus and species of each should be written on the back of the card. Of course, these tubes must have a specially constructed cabinet, with hollows for their reception, so that each may lie securely and not be loosely rattling about. One advantage of this method is the total freedom from any chance of their being attacked by mites.

Specimens of most of the medium-sized insects should be rendered transparent and mounted in balsam without pressure. The details of the process for accomplishing this I have described in the *Journal of Microscopy*, July, 1885, p. 151. When any insect is prepared in this way, all the organs can be seen in their proper position and can be examined with any power of the microscope, so as to make out the exact shape and character of any particular part. Of the larger species, heads should be prepared in this manner, and it will be found that the best result is obtained by cutting the head in halves at the sides, so as to have the clypeus, labrum, and mandibles in one object, and at the side, or above it, the ventral portion of the head—namely, the mentum, labium, maxillæ, palpi, etc.—as another object, but mounted in the same cell. The smaller insects and parts of larger ones may be mounted in balsam in the usual way with pressure. This method, at the best, somewhat distorts the shape of the insect, and alters the relative position of the parts; but as we have the same insect as a solid object to refer to as a guide to general form and colour, this is not of so much moment. The method has many advantages, particularly for small objects, when used in its proper sphere.

These slides must, of course, be kept in the usual microscopic cabinet. That form in which each slide lies flat is decidedly preferable. Each slide must bear a distinctly marked number, so that it may be replaced in the cabinet in a moment. For finding them a register must be kept having an index to the genera at the end. Having found the page in the register where the genus occurs, it is very easy to find the species and the particular object, which will show exactly what is wanted.

I fear many entomologists will object to the system I have tried to sketch out on account of the trouble and time it would take to make a collection with any completeness in this way. No doubt it would take a good deal of time and a great deal of application, but I maintain that the genuine student of Nature knows no such thing as trouble, and if the time at his disposal is not sufficient to deal with the whole of the Coleoptera, for instance, let him take one group, such as the *Geodephaga* or the *Hydradephaga*, and work it out in a genuine and conscientious way. Not only would his collection be more useful and interesting, but the information he would be able to impart would be of considerable scientific value. It is decidedly better to take a group and make a collection of it in as complete a way as possible, and to study the structure of the insects so as really to know something about them, than it is to collect thousands of species, and merely place them in drawers or boxes, and know nothing more about them than simply to recognise the insects at sight.

In conclusion, I would wish most emphatically to express my conviction, whether the foregoing ideas of making collections be accepted or not, that certainly the majority, if not all, of our collectors of insects would get on better and make more genuine advancement if they would use the compound microscope more generally than they do.

The Microscope and How to Use it.

By V. A. Latham, F.M.S.

Part VII.

Hardening Agents.—The most essential point in microscopic investigation is the proper hardening of the material to be examined, and this must be done gradually, as if any tissue is placed in a strong solution the elements of which it is composed at once shrink, and it is impossible to form a correct idea of their nature. It will be impossible to give more than the usual strengths of the fluids, as it is only by constant practice and experience that the strengths can be learnt; each fluid differing slightly for the various organs, and most histologists use various strengths. Hardening solutions, as a rule, do not require filtering. The best plan is to make a large quantity at a time—say, a Winchester quart,* which holds about 2,400 cc. of water. This quantity should be measured into the bottle, and the height of the fluid marked on it with a diamond. The amount of the chemical used should be written on the label, so that when a new supply is wanted the bottle has only to be held under the tap until the water reaches within a few inches of the mark. The quantity of the hardening agent is then weighed out and put in the funnel, and the bottle filled up to the mark. This method answers with substances which dissolve readily; others have to be pounded in a mortar with warm water.

A.—Hardening.

Chromic Acid, 1 per cent. solution.—Weigh 10 grammes of crystallised chromic acid, and dissolve in 1 litre of distilled water. This can be diluted as required. I generally make a 1—6th per cent. (15 grammes to the pint).

Chromic Acid and Spirit.—The most useful hardening agent is this mixture:—Make a 1—6th per cent. solution—1 gramme to 600 cc., or 15 grains to the pint. Take of this 2 parts, and ordinary methylated spirit 1 part. Stir and allow to cool before using. To use the solution, the material must be cut into small pieces,

* A Winchester quart is a glass bottle holding about half-a-gallon.—Ed.

about a quarter to half-an-inch square, and a large quantity of fluid used; a large, wide-mouthed, stoppered bottle, holding from six to ten ounces, according to the quantity of material, is best. Change the fluid at the end of twenty-four hours, and again every third day, and the material will be hardened in from eight to twelve days, as can be easily proved by taking out a piece and feeling it. If not hard enough, they feel elastic like India rubber when slightly pressed between the thumb and finger. If allowed to remain *too* long, it gets brittle. When it is found to be moderately hard, usually after about eight or ten days, pour off the chromic acid mixture, and wash well; replace it by dilute spirit, made thus:—Methylated spirit, 2 parts; and water, 1 part. Let the material remain in this for from twenty-four to thirty-six hours, never longer than three days, and then replace it by pure methylated spirit. It may remain in this for an indefinite time, but it will often be found that the spirit becomes cloudy and full of deposits in a few days. In this case, it is only necessary to change the spirit until it remains clear. In some cases a 1—6th solution of chromic acid may be used without the spirit with advantage. In other cases, it may be necessary to use a solution much weaker, as a 1—10th per cent.

Chromic and Bichromate Solution.—Dissolve 1 gramme chromic acid and 2 grammes potassium bichromate in 1,200 cc. water.

Chromic and Nitric Fluid.—Chromic acid, 1 gramme; water, 200 cc.; then add slowly 2 cc. nitric acid.

Chromic and Osmic Acids.—A mixture of chromic acid with a few drops of osmic acid is often very useful, as it combines the advantages of both reagents. Since I used the above, Dr. Max Flesch has brought out a modification, which is as follows:—Osmic acid, 0·10; chromic acid, 0·25; distilled water, 100 parts. Mix. It answers particularly well for the auditory organs of smaller animals, many details of structure of the cochlea coming out with quite diagrammatic clearness. The hairs of the air-cells are, however, mostly lost. It answers well for examination of the growth of bone in the epiphyses of small animals, and for general views of the retina, conjunctiva, cornea, and eyelids. In

these latter many details suffer, especially the bacillary layer of the retina. The objects for examination are placed fresh in the fluid, and kept there from twenty-four to thirty-six hours. There is no need to keep them in the dark, as the osmic acid, in conjunction with chromic acid, does not undergo such rapid changes by light as when alone. In the case of cochlea, young bones, etc., a further treatment with 0·25 per cent. to 0·5 per cent. of chromic acid may be necessary for complete decalcification. The object is then washed and placed in spirit, and the sections, when cut, may either be examined in glycerine, or treated successively with alcohol and turpentine, and then mounted in Canada Balsam. The great advantages of this fluid are its rapid hardening properties, and the fact that no further staining is necessary, the osmic acid giving sufficient colour to the cells even when mounted in balsam.

Muller's Fluid takes a longer time to prepare than chromic acid. It is made as follows:—Bichromate of Potass., 2 parts; sulphate of soda, 1 part; water, 100 parts. The ingredients should be pounded in a mortar, and then warm water added until they are dissolved. The advantages of this mixture are, first, that larger pieces can be hardened in it; second, it does not require changing after the first week or two, but it will take from five to seven weeks to harden anything, according to its size. When sufficiently hardened, wash well and place in dilute spirit, as recommended for the chromic acid mixture.

Muller's Fluid, a Variation of (sometimes called Ehrlich's hardening solution).—Take bichromate of potash, 2 to 2½ parts; sulphate of copper (½ per cent. solution) 1 part (instead of sulphate of soda); and water, 100 parts. The hardening properties are far superior to those of Müller's fluid.

Muller's Fluid and Spirit.—Three parts of Müller's fluid and 1 part of methylated spirit. It is good for nerve tissues, muscle, and retina. This must be kept in a dark place to prevent the chromium salts from separating.

Methylated Spirit.—Many tissues can be hardened in spirit alone if they are placed in dilute spirit at first, so that the ele-

ments of which they are composed are not shrunk. This process is also used after hardening by any of the other methods. Dilute spirit is made by adding 1 part of water to 2 parts of methylated spirit. Material to be hardened must not be left in the mixture more than from twenty-four to forty-eight hours; then transferred to pure spirit.

Bichromate of Potash, 1 or 2 per cent. solution.—Dissolve 20 grammes of the salt in 1 litre of water. A solution can be made much more quickly with warm water than with cold. The hardening of the material takes from three to seven weeks, according to the size of the specimen, and the frequency with which the solution is changed.

Bichromate of Ammonia.—A 2 to 5 per cent. solution is used precisely in the same manner as the former. Useful for Brain, Spinal Cord, and Nervous System generally.

Ammonium Chromate.—Make a 5 per cent. solution—that is, 1 oz. of the salt to 20 ounces of water, or 5 grammes to 100 cc., and filter. It hardens fresh tissue as the mesentery in twenty-four hours, which must then be washed until no more colour comes away, and is invaluable for revealing the rod-like structure in the renal epithelium of the kidney, and demonstrating the existence of the intra-cellular and nuclear plexus of fibres in cells.

Absolute Alcohol.—Of s.g., 0·795. This hardens very rapidly, in twenty-four hours; but it causes considerable shrinking, though it is invaluable for gastric mucous membrane and for secretory glands in general—*e.g.*, salivary glands and pancreas. Tissues become stained very readily after hardening in pure alcohol.

Ranvier's Alcohol (Alcool au tiers).—Mix 1 part of rectified spirit with 2 parts of distilled water.

Iodine.—One part of iodine combined with 3 parts of iodide of potassium to 500 of water is used for tinging animal cells. It serves for the recognition of amylum, and, in combination with sulphuric acid, of amyloid substances and cellulose.

Caustic Potash (hydrate of potassa).—Thirty per cent. to 35

per cent. solutions are excellent re-agents. An exposure of from a quarter to half an hour or more is an extremely useful means of isolating muscular and nerve elements, glandular passages, and even ordinary ciliated and olfactory cells.

Chloride of Iron is used by Billroth and Führer for hardening spleen, which becomes sufficiently hardened in from one to two hours in a solution of the colour of Madeira or Malaga wine.

Chloride of Mercury.—The chemical effects of the sublimate are well known. Macerating for several days in a solution of this salt may be advantageously used for hardening and isolating the axis cylinders. This re-agent forms an element of several very serviceable preservative fluids.

Chloride of Platinum hardens and gives flattened organs a diffused yellow tinge. Equal portions of chromic acid and chloride of platinum (each 1·400) are recommended for the connective tissue framework of the retina.

Alcohol and Acetic Acid renders spinal cord marvellously clear, even in a few hours, and permits many things to be better recognised than by any other methods. The recipe is, naturally, to be modified according to necessity. The proportions usually used are 3 parts alcohol with 1 part acetic acid (L. Clarke).

Moleschott's Strong Mixture modified from Clarke's Method. Strong acetic acid (1·070 s.g.), 1 part; alcohol (0·815 s.g.), 1 part; distilled water, 2 parts. Very serviceable for hardening many organs; causes connective tissue portions to become transparent, renders albuminous matters distinctly prominent.

Beale's Alcohol, Acetic, and Nitric Acid, for Examination of Epithelial Structures, etc.—Water, 1 ounce; glycerine, 1 ounce; spirit, 2 ounces; acetic acid, 2 drachms; hydrochloric acid, ½ drachm.

Alcohol and Soda.—Eight to ten drops of caustic soda to each ounce of alcohol. Tissues are rendered very hard and transparent, particularly adapted for investigating calcareous matter deposited in various morbid processes; also, in tracing the stages of ossifica-

tion in the early embryo. A fœtus, prepared by being soaked for a few days in this fluid, and preserved in weak spirit, forms a very beautiful preparation. Useful also for soft granular organs, and of special service for the liver (Beale).

Collodium is used for recognising the axis cylinder of nerve fibres.

Sulphuric Acid is useful in investigating horny structures (the cornified epithelium, the nails and hair), and for isolating the cells of these tissues. Alone, or combined with iodine, it forms a good re-agent for cholestrin, and in combination is useful for cellulose and amyloid substances. Sugar and sulphuric acid redden many organic substances, such as albuminous and amyloid bodies, oleic acid, etc.

Nitric Acid, mixed with chlorate of potash, destroys connective tissue in a short time, and is therefore a good medium for isolating muscular fibres (Kühne). Strong acid is used for isolating connective tissue corpuscles, bone corpuscles and their processes, and also for dentinal canals.

Hydrochloric or Muriatic Acid dissolves the intercellular substance of connective tissue organs, and for isolating the connective tissue corpuscles and their radiating tubular systems, as in the cornea, teeth, and bones. It also dissolves the intercellular substance of the muscles (Aeby) and of the urinary tubes (Henle).

Pyroligneous Acid (or acidum pyrolignosum rectificatum) is used for rendering connective tissue structures transparent, and, with a certain pre-dilection, is used also for pathological tissues, for recognition of corneal cells and contents, course of nerves in sub-mucous connective tissue, structures imbedded in connective tissue, as pathological new formations, glandular elements, and for extracting the bone earths from calcified cartilage and from normal and pathological bone-tissues.

Acetic Acid renders muscles transparent, so that the nerve terminations may be discerned, and vinegar is used to boil such animal tissues as are to be dried.

Selected Notes from the Society's Note-Books.

Staining.—I think there can be no doubt that staining adds to the value of a slide. It differentiates the component parts of tissues, and enables the elements to be recognised with much more facility. Not that an educated eye cannot distinguish them without staining, but I find from experience that in demonstrating histological specimens to men who see the structure for the first time, it is useless to show unstained ones. I have used chiefly hæmatoxylin and carmine fluids. Carmine does not as a rule stain so evenly as hæmatoxylin, and it takes a much longer time, which is an objection with delicate sections, and, moreover, there is such a glare caused by it—especially when working at night—that the object becomes more or less hazy, thus counteracting to some extent the value of the staining. The fluid which I always use, and which I strongly recommend, is as follows:—Extract of Hæmatoxylin, 1 drachm (60 gr.); Alum, 3 drachms (180 gr.). To be well rubbed together in a mortar, and then 5 drachms of water added by degrees whilst still triturating. Filter, and to the filtrate add Rectified Spirit, $\frac{1}{2}$ drachm. For use, three or four drops of this fluid should be added to two drachms of water in a watch-glass, and the mixture carefully filtered, as some precipitation occurs.

E. C. Bousfield.

Spine of Dog-Fish.—The "spine" (scale) of dog-fish, like that of other placoid fishes, shows an approach to tooth-structure; the dentinal tubules are stouter and more branched, and less parallel than those of the mammalian tooth, though closely resembling those of the teeth of some fishes. The enamel seems absent.

H. F. Parsons.

Shell of a Brachiopod.—Brachiopods differ from ordinary bivalves, in that the valves are front and back, instead of right and left. The ventral valve is prolonged in many species into a perforated beak, like that of an ancient Roman lamp; hence, they are called "lamp shells." There are also internal anatomical differences so great, that by some modern zoologists the Brachiopods are removed altogether from the Mollusca. The existing Brachiopods are the few lingering remnants of a once numerous family. If nobility be measured, as some people measure it, by length of

pedigree rather than by personal qualities, the Brachiopods may claim to be the aristocracy of the animal kingdom, for they have existed almost unchanged from the time when nearly the earliest fossiliferous rocks were deposited to the present day. The shells are generally well preserved both in form and structure. *Terabratula intermedia* is a large oolitic species, one of the common and characteristic fossils of the corn-brash. It often retains traces of a yellowish colour. The shell of *Terabratula* is composed of elongated prismatic fibres, placed obliquely to the surface, and perforated by numerous minute canals, which run from the inner surface nearly to the outer, and in the recent state contain processes of the mantle.

In *Rhynchonella* the structure is similar, but the perforations are wanting. *Rhynchonella obsoleta* is a long species, common in the Bradford clay (lower oolite). The cavity in the specimen before us is filled with crystals of calcite. Such slides should be viewed with the polariscope and selenite.

H. F. PARSONS.

Proboscis of Drone Bee.—Is the shortness of the proboscis of the Drone Bee the cause of the shortness of its life, and does it die of hunger after being driven from the hive?

E. HUNTER.

Staining.—The logwood stains have become general favourites among surgeons, especially those in hospital practice, as the rapidity of action enables a portion of excised tissue to be stained and examined before the patient is removed from the operating table. Schäffer's formula, substantially the same as Mr. Bousfield's, is as follows:—Five grammes Extract of Logwood and 5 grammes Alum rubbed up thoroughly in a mortar with 100 cc. Water. The mixture to be covered and allowed to stand overnight, then filter, and add a few drops of Peroxide of Hydrogen. Will keep for two or three weeks, but requires to be filtered immediately before use.

W. TEASDALE.

Shell of Box Fish.—The hexagonal plate of the defensive armour and the dentated suture of this sluggish fish suggest extreme facility for the growth of the animal by marginal accretion of new material. I bought three little box fishes from a Parsee at Suez some fifteen years ago, but have reason to suppose that they came from the China and not from the Red Sea, although they are found in both, and also in the waters which lave the shores of

intertropical America. In some of the species a transverse section of the body is triangular in outline, in others quadrangular, and because my little specimens were triangular, I perhaps too hastily adopted the specific name, *Triquetra*, which belongs to the largest of the genus, about 18 inches long, whereas mine are barely three inches long.

WASHINGTON TEASDALE.

Templetonia nitida is one of the scale-bearing Podura, figured in Mr. McIntyre's paper in *Science Gossip*, Vol. III., p. 57. It is not, I believe, considered a "test" scale. *Templetonia nitida* well deserve their name; they are very pretty, cream white, active little fellows. I have generally a few about my window plants, with the curious *Campodea*.

H. E. FREEMAN.

Parasite of Elephant—Idolocoris *v.* Hæmatomyzus Elephantis —is well figured and described by Mr. Richter in *Science Gossip*, 1871, p. 131, and is also mentione din Murray's *Economic Entomology* as *H. Elephantis*, on p. 385. It is considered to come between the *Pediculidæ* and the *Cimicidæ*. "It resembles the former in the number of joints in and structure of the antennæ, in the number of segments of the abdomen, and in the single claw terminating the tarsi. It differs from bugs in the antennæ, in the unjointed and produced rostrum, and in the single tarsal claws. The spines of the body and extremities are also quite unlike the characteristic spines of the bugs. The structure of the rostrum is very complex, and with its reflected plates or teeth it somewhat resembles the central organ of the trophi of the Ixodes. Eyes simple. In every particular this strange little insect appears to be exactly fitted for the locality where it is stated to occur" (Richter). It appears to me to come nearer to the *Hæmatophini* than the bugs, while it also approaches the Ixodes, as indicated by the rostrum; at any rate it is a fine illustration of adaptation to peculiar circumstances.

H. E. FREEMAN.

Templetonia nitida is one of the spring-tailed family which has proved so destructive to the underground telegraph wires. There is a very excellent monograph on the family by Sir John Lubbock, and published by the Ray Society. The genus was named *Templetonia* by him.

W. H. PREECE.

Fredericella Sultana.—This is one of the fresh-water Polyzoa. Some of the tentacles are extended. This was effected by placing a portion of the Polyzoa in a deep vessel containing a little water ; then, seeing that the tentacles were extended, I suddenly added *boiling* water, which appeared to produce instant death. If instead of merely mounting the *houses*, as is usually the case, we could have the inmates peeping out of the windows, collections of marine and fresh-water Polyzoa would be much more interesting. The boiling-water plan appears to me likely to prove effectual, but if any friends have had better success with alcohol or osmic acid, the information would be welcomed by many.

ISAAC C. THOMPSON.

Reviews.

PRACTICAL INTRODUCTION TO CHEMISTRY. By W. A. Shenstone, Lecturer on Chemistry in Clifton College. Crown 8vo, pp. xiv.—109. (London: Rivingtons. 1886.) Price 2s.

This little book is intended to give pupils a sound knowledge of some of the chief elementary facts of chemistry. This, the author very properly insists, can only be done by habituating them to experiment, to observe, and write out clear accounts of the results of each experiment for themselves. He also advocates the early use of the balance and other instruments of precision, in order to obtain quantitative results. This must prove a handy little work for young pupils who are taught to use their own hands in chemical work.

THE CHEMIST'S POCKET BOOK; for Chemical Manufacturers, Metallurgists, Dyers, Distillers, Brewers, Sugar Refiners, Photographers, Students, etc. By Thomas Bayley, Assoc. R.C.Sc.I. Fourth edition. (London : E. & F. N. Spon, 125, Strand.) Price 5s.

This small Pocket Book will save every practical chemist who uses it a vast amount of time in searching various publications for special tables and the technical information he requires. It is nicely got up, and the type, though necessarily small, is clear, It should meet with a large sale, as it appears to supply a distinct want.

A MANUAL OF CHEMISTRY. By A. Dupré, Ph.D., F.R.S., etc. etc., and H. Wilson Hake, Ph.D., F.C.S., etc.; with a coloured table of Spectræ. (London : C. Griffin and Co. 1886.) Price 7s. 6d.

This is a well written and nicely-arranged text-book, which will be found useful to chemical students of all classes. Amongst its more prominent features are the physiological actions of the substances on which it treats, and the very useful footnotes giving the origin of many of the technical terms used. We are pleased to be able to recommend it heartily.

QUALITATIVE CHEMICAL ANALYSIS, Inorganic and Organic. Part I.—Elementary Stage. For Schools and Science Classes. By J. Patchett, F.C.S., 1st B.Sc. (Lond.). Crown 8vo, pp. 44. (Leeds : Bean and Son ; London : Simpkin, Marshall, and Co.) Price 1s.

A little work of 44 pages, giving the chief tests for 24 metals, and the principal acids. It is quite elementary. Its chief feature consists in the reactions which occur during each test being given under the test in the form of an equation.

SIGNS AND SEASONS. By John Burroughs, author of "Wake, Robin," "Winter Sunshine," etc. Royal 16mo, pp. 289. (Edinburgh: D. Douglas. 1886.) Price 6s.

A book with which the naturalist will be charmed. The table of contents embraces—A Sharp Look-Out, A Spray of Pine, Hard Fare, The Tragedies of the Nests, A Snow Storm, etc. etc. It is a book full of interesting facts relating to the Animal and Vegetable Worlds.

SEA-WEEDS, SHELLS, AND FOSSILS. By Peter Gray, A.B.S. Edin., and B. B. Woodward, of the British Museum. Post 8vo, pp. 94.

ENGLISH COINS AND TOKENS. By Llewellyn Jewitt, F.S.A. With a Chapter on Greek and Roman Coins by Barclay V. Head, M.R.A.S., etc. Pp. 128. (London: Swan Sonnenschein, Le Bas, and Lowrey. 1886.) Price 1s. each.

The above form two volumes of "The Young Collector" very useful series of books; a series with which we are much pleased. They each give a good epitome of the subjects of which they treat, and are both well illustrated. The volume on Coins gives also a good account of many of the Trader's Tokens of the 17th century, whilst that on Sea-Weeds, Shells, and Fossils, gives some good hints as to where the collector should look for these things, and how to arrange and preserve them when obtained.

WHERE DID LIFE BEGIN? A Brief Enquiry as to the Probable Place of Beginning and the Natural Courses of Migration therefrom of the Flora and Fauna of the Earth. A Monograph, by G. Helton Scribner. Post 8vo, pp. vi.—64. (New York: C. Scribner and Sons. 1883.)

In this little Monograph the author bases his arguments on the generally accepted theory of the gradual cooling of the earth, and that consequently the poles must at one time have been the only spots capable of sustaining life. We think his arguments throughout are very reasonable.

RUS IN URBE: or, Flowers that Thrive in London Gardens and Smoky Towns. By Mrs. Haweis. Illustrated. Sq. 16mo, pp. 136. (London: Field and Tuer.) Price 1s.

Mrs. Haweis assures us that many plants *will* grow in London, if only proper means be adopted; and it is her object in writing this little book to tell how that object may be attained. The book is divided into three parts—The House with a Garden; The Garden in the House; and What will Grow; followed by a long list of Trees, Shrubs, Ferns, etc. etc.

A BOOK ABOUT BEES: Their History, Habits, and Instincts; together with the First Principles of Modern Bee-Keeping for Young Readers. By Rev. F. G. Jenyns, Rector of Knebworth. With Introduction by the Baroness Burdett-Coutts. Post 8vo, pp. xxiv.—200. (London: Wells, Gardner, Dalton, and Co. 1886.) Price 3s. 6d

This little book, which is most pleasantly written, gives a very plain account of the Habits, the Work, and in fact the Natural History of the Bee. The best kind of Hives are described, and full instructions for the management and care of Bees. It is nicely illustrated with several full-page and smaller engravings.

THE SCIENTIFIC ANGLER: Being a general and instructive work on Artistic Angling. By the late David Foster (compiled by his sons). Crown 8vo, pp. viii.—354. (London: Bemrose and Sons. 1886.) Price 3s.

The work before us, now in its third edition, goes very thoroughly into the science of Angling. It treats of the Habits and Haunts of Fish, Bottom Fishing, and Pike Fishing. There is a good chapter on Piscatorial Entomology, in which a great variety of Artificial Flies are discussed, coloured plates of the real and artificial flies being given side by side. Several plates are also devoted to Apparatus.

HOW TO PHOTOGRAPH MICROSCOPIC OBJECTS: A Manual for the Practical Microscopist. By J. H. Jennings. 8vo, pp. 36. (New York: E. and H. T. Anthony and Co.) Price 50c.

The instructions here given appear to be very practical. We do not remember to have seen the book published by an English firm, although the publishers tell us that "the author's standing among English scientific workers is a sufficient guarantee for the thoroughness of the methods described." The subjects treated of may be briefly described as follows:—The Microscopical Photographic and Illuminating Apparatus; Exposing the Plate; Development; Defects in the Negative; Printing; Preparing Objects for Photography, etc.

THE AMATEUR PHOTOGRAPHER: A Manual of Photographic Manipulation, intended especially for Beginners and Amateurs. By Ellerslie Wallace, jun., M.D. Crown 8vo, pp. 205. (Philadelphia: Porter and Coates.) Price $1·00.

This is an excellent hand-book, containing a large amount of information. The directions appear sufficiently practical and complete to enable anyone to learn the photographer's art. The table of contents embraces all the usual subjects, including microscopic photography. The volume is nicely bound and illustrated with suitable engravings and a fine silver-print frontispiece.

THE HOMES OF THE BIRDS. By M. K. M., Author of "The Birds we See," etc. Crown 8vo, pp. 243. (London: T. Nelson and Sons. 1886.) Price 2s.

In a series of seventeen very interesting chapters the author conducts us to the homes of the birds, and gives us an account of their natural history; some of the scenes visited being—The Mountain and Desert, The Ocean and Shore, The River-side, etc. The book is illustrated with 65 engravings by Giacomelli.

THE BUTTERFLIES OF THE EASTERN UNITED STATES, for the use of Classes in Zoology and Private Students. By G. H. French, A.M. Crown 8vo, pp. 402. (Philadelphia, U.S.A.: J. B. Lippincott and Co. 1886.) Price $2.

This work gives a brief description of the several stages of butterflies, their habits, methods of capture, killing, and preservation, rearing butterflies from eggs and larvæ. The accentuated list of butterflies will be found very serviceable for young students and collectors. The book is nicely printed and well illustrated.

HAZELL'S ANNUAL CYCLOPÆDIA, 1886. Edited by E. D. Price, F.G.S. Revised to the end of March, 1886. Crown 8vo, pp. xii., 566. (London: Hazell, Watson, and Viney. 1886.) Price 3s. 6d.

This most useful Cyclopædia contains nearly 2,000 concise and explanatory articles on every topic of current political, social, and general interest referred to by the Press and in general conversation. It is claimed for it that it provides UP TO DATE information only on such subjects as are now, or are likely soon to be, in the mind of the public, thus forming a companion to the newspaper and a guide to every-day topics of conversation. It contains an unusual amount of most valuable information.

STORIES OF MY PETS: Tales of Birds, Beasts, and Reptiles. By the Author of "Moravian Life in the Black Forest," etc. Crown 8vo, pp. 240. (London: Swan Sonnenschein and Co. 1886.) Price 1s. 6d.

In this very cheap little book we have some capital stories, which we are informed by the author are all true. Many of the pets really belonged to him, and their wonderful little ways and doings are in nowise exaggerated. The tales are charmingly told, and must interest young readers.

THE QUEEN'S RESOLVE: "I will be good"; with Anecdotes and Incidents. A Humble Memorial. By Rev. Charles Bullock, B.D. Royal 8vo, pp. 64. (London: *Home Words* Office. 1886.) Price 2s. 6d.

This handsomely got up volume, by the Editor of *Home Words*, forms a graceful memorial of her Majesty's Jubilee, and will doubtless be read with much interest by a great number of her loyal subjects. The frontispiece to the volume is a likeness of the Queen from life, by George H. Thomas, from a picture lent by the Earl of Bradford, and bears her autograph. The other illustrations are numerous and good.

MAN AND HIS HANDIWORK. By the Rev. J. G. Wood. Crown 8vo, pp. xii, 668. (London: Society for Promoting Christian Knowledge. 1886.) Price 10s. 6d.

This is, we think, one of the most interesting of Mr. Wood's works. It is, to use his own words, "in no sense a treatise on Technology, but a brief sketch of human handiwork. It deals with man, to whom was given the Divine command to subdue the earth, and shows some of the means by which he is steadily carrying out his high mission."

In a most pleasing way the author begins by comparing the hands and feet of man to those of the gorilla and other animals. The primitive pick-axe is then described, followed by some of the earlier homes of man. Then his war-implements and instruments used and methods resorted to in procuring food, and finally some of the luxuries of savage life, musical instruments, the pipe, etc., are described. The illustrations are good and very numerous.

THE NEW AGRICULTURE, or, The Waters Led Captive. By A. N. Cole. 8vo, pp. 223. (New York: The Angler's Publishing Company. 1885.) Price $2.

Mr. Cole describes here a process of sub-surface drainage and irrigation, from which he has obtained most wonderful results, cereal crops being increased fourfold. The size, flavour, and production of fruit increased fivefold. Vegetation is said to be rendered absolutely free from disease, and drought effectually prevented. The book is nicely illustrated.

THE NATURALIST'S DIARY: a Day-Book of Meteorology, Phenology, and Rural Biology. Arranged and edited by Charles Roberts, F.R.C.S., L.R.C.P., etc. With a Chart showing the Blossoming of Spring Flowers in Europe, and an Introduction on Natural Periodic Phenomena, etc. 8vo, pp. xlvi., 365. (London: Swan Sonnenschein and Co. 1886.) Price 2s. 6d.

Every practical naturalist will find this a most useful book in which to make daily observations. There is a page for every day of the year. Each page is divided into two columns, one being printed and the other left blank for new entries, and the blank spaces between the different sections or headings are for entries of new observations. At the date of the earliest appearance of flowers, insects, etc., the naturalist is told to LOOK FOR such. Naturalists will be glad to avail themselves of so complete a diary.

EVOLUTION *versus* INVOLUTION : A Popular Exposition of the Doctrine of True Evolution, a Refutation of the Theories of Herbert Spencer, and a Vindication of Theism. By Arze F. Reed. 8vo, pp. xii.—275. (New York : Jas. Pott and Co. 1885.) Price $2·50.

The chief object of the author of this work is to stem the torrent of sceptical or Agnostic belief which is sweeping away old land-marks and essaying to undermine the very foundations upon which religion and morality are based. The first chapter is devoted to a brief historical sketch of the subject, the second defines what is to be understood by Evolution, and in succeeding chapters the subject of COSMOGENESIS, or the Evolution of the Universe, is ably discussed under various heads, *e.g.*, Astrogenesis, Biogenesis, etc. etc.

WHERE ARE WE AND WHITHER TENDING ? Three Lectures on the Reality and Worth of Human Progress. By the Rev. M. Harvey. 8vo, pp. 134. (Boston, U.S.A. : Doyle and Whittle. 1886.) Price 75c.

The question of human progress is unquestionably one of very considerable importance. In the pages before us the whole subject is carefully reviewed, and whilst the difficulties and objections suggested by Pessimists are freely stated and carefully considered, the author builds his strong arguments in the reality of progress on the slow and gradual accretions of good which the past has witnessed, and the steady diminution of evil which is clearly discernible. The book will repay a careful perusal.

EVOLUTION AND RELIGION. Part II. Eighteen Sermons discussing the Application of the Evolutionary Principles and Theories to the Practical Aspects of Religious Life. By Henry Ward Beecher. Pp. 440. (London : Janes, Clarke, and Co. 1885.) Price 5s.

On a former occasion it was our pleasure to notice the first part of this series of sermons. They are all written with Mr. Ward Beecher's usual eloquence, and deal more especially with the application of evolutionary principles and theories to the practical aspects of religious life, and their effect upon its duties, hopes, fears, and tendencies at the present time.

GARDENS OF LIGHT AND SHADE. By G. S. C. Crown 4to, pp. 70. (London : Elliot Stock. 1886.) Price 10s.

A handsome volume ; well printed, and illustrated with a number of fine photos. The writer endeavours to show how insignificant plots of ground may be made to yield something in perennial beauty ; and with the information he has here given, supplemented perhaps in regard to details of planting and treatment by some good work on gardening, it is possible that many suburban plots, now given over to nine months' barrenness, may be made pleasing all the year round at small cost.

EUCLID REVISED. Part I. Containing the Essentials of the Elements of Plane Geometry as given by Euclid in his First Four Books. With additional Propositions and Exercises. Edited by R. C. J. Nixon, M.A. Crown 8vo, pp. viii.—222. (Oxford : The Clarendon Press. 1886.) Price 3s. 6d.

This is not merely a new edition of Euclid, but one which shows considerable originality in the demonstration of the propositions. Unlike most works on the subject, the definitions, axioms, etc., are introduced as required, and copious notes are included wherever necessary. The type and drawings are clear and accurate, and there is a freshness about the whole work, which, together with the numerous deductions, recommend the book as one that, in the hands of an able teacher, should make the learning of Euclid not so mechanical an art as it often is.

THE UNRIVALLED COOK-BOOK and Housekeeper's Guide. By Mrs. Washington. 8vo, pp. viii.—640. (New York: Harper Bros. 1886.)

An unlimited amount of excellent receipts, some 200 of which are from Creole sources, whilst others are North and South American, English, Scotch, French, German, Italian, and Russian. We scarcely expected to find receipts for Devonshire Clotted Cream, or for Oatmeal and white Scones, in a book published on the other side of the Atlantic. We find the various receipts arranged together under their various heads, thus saving the reference to a large index. At the end of the book are blank pages for additional receipts.

THE CREOLE COOKERY BOOK. Edited by the Christian Woman's Exchange of New Orleans, La. Crown 8vo, pp. xxvi.—216. New Orleans: T. H. Thomason. 1885.)

We have here some 900 recipes for the preparation of every conceivable kind of Soup, Fish, Meat, Bread, Pastry, etc., from that part of the United States where Thackeray says "you can eat the most and suffer the least." Many of the dishes are doubtless good, although some we think contain too much of a mixture to please us. There are a number of blank leaves for extra receipts at the end of the book. The Creole cook, whose portrait forms a frontispiece to the volume, is not a beauty in our estimation.

AN AID TO THE STUDY OF MORAL PHILOSOPHY. Specially designed for Students Preparing for Examination. By Auxilium. First, Second, and Third Series. Crown 8vo, pp. 280. (Glasgow: W. S. Sime; London: Houlston and Sons. 1886.) Price 6s.

The subject of Moral Philosophy is so extensive, that few students, if left to themselves, can undertake it successfully with their other studies. The object of the work before us is to give an outline, in a condensed form, of the subjects treated, in their order; so that anyone who wishes to devote himself to the study of Moral Philosophy, may become comparatively familiar with the subject before entering the class. We believe the work may also be had in three parts separately, which will perhaps be found more convenient.

ARMY AND CIVIL SERVICE Examination Papers in Arithmetic, including Mensuration and Logarithms, with Arithmetical Rules, Tables, Formulæ, and Answers. With an Appendix containing Supplementary Papers to date. By the Rev. A. Dawson Clarke, M.A. Pp. 294. (London: Rivingtons. 1866.)

The Arithmetical Rules, Definitions, etc., which occupy the first 50 pages, are concise, clear, and good, and will prove of great practical value. The rest of the book consists of copies of Examination Papers for admission to the Army, Civil Service, etc. etc.; the carefully working out of them will, in our opinion, well repay the student.

HOBBES. By George Croom Robertson, Grote Professor of

Philosophy, of Mind, and Logic in University College, London. Pp. vii.—240. (Edinburgh and London: W. Blackwood and Sons. 1886.) Price 3/6.

In the work before us the author has endeavoured to bring together all the previously known, or now discoverable facts of Hobbes' life, and to give some kind of fairly balanced representation of the whole range of his thought, instead of dwelling only on those humanistic portions of it by which he has commonly been judged. It forms one of the volumes of Blackwood's Philosophical Classics.

THE PHILOSOPHY OF ART. An Introduction to the Scientific Study of Æsthetics. By Hegel and C. L. Michelet. Translated from the German by W. Hastie, B.D. Crown 8vo, pp. xvi.—118. (Edinburgh: Oliver and Boyd. 1886.) Price 2s. 6d.

This little book consists of two parts. I.—Hegel's Introduction to the Philosophy of Art as the Science of Æsthetics, and II.—Michelet's Philosophy of Art, which is further subdivided into Formative Art (Architecture, Sculpture, Painting), Musical Art, and Poetical Art (Epic, Lyrical, and Dramatic Poetry).

THE LIFE AND GENIUS OF GOETHE. Lectures at the Concord School of Philosophy. Edited by T. B. Samborn. Crown 8vo, pp. xxv.—454. (Boston: Ticknor and Co. 1886.)

A series of thirteen lectures which were delivered by various professors and others at the Concord School of Philosophy in July, 1885. They treat of Goethe's Youth; Goethe's Self-Culture; Goethe's Titanism; Goethe as a Playwright, etc. etc. Two portraits are given, one representing him in his youth, before publishing any except his earliest works; the other is engraved from Rauch's bust, which was made in August, 1820, when Goethe was seventy-one years of age. A Bibliography of Goethe's works, and of works relating to him, is also added.

THE GLASSE OF TIME in the First and Second Age. Divinely handled. By Thomas Peyton, of Lincolne's Inne, Gent. Seene and allowed. London: "Printed by Bernard Alsop for Lawrence Chapman, and are to be sold at his shop over against Staple Inne. 1620." Pp. 177. (New York: John B. Alden. 1886.)

An extremely rare poem, written some years before Milton's great works, and is supposed to have been the source of his conception of Paradise Lost. In the introduction to this book several parallel passages are given. It is an accurate transcript of the valuable copy in the British Musem, the quaint spelling, punctuation, and use of capital letters of the original being maintained.

GLIMPSES OF MAORI LAND. By Annie R. Butler. Post 8vo, pp. x—260. (London: The Religious Tract Society. 1886.)

We would recommend those of our readers who are interested in mission work to read this book. It gives a graphic description of the country, and a most interesting account of character and customs of the Maori, and the progress these people are making under Christian and civilising influence. The illustrations add much to the interest of the book.

THROUGH TUMULT AND PESTILENCE. By Emily M. Lawson. Crown 8vo, pp. 159. (London: The Society for Promoting Christian Knowledge. 1886.) Price 1s. 6d.

A particularly interesting tale of the Bristol Riots, which occurred in 1831, and of the Cholera time. It is illustrated by J. Nash.

A WORKING MAN'S PHILOSOPHY. By One of the Crowd. Crown 8vo, pp. 116. (London: Chapman and Hall. 1886.) Price 3s.

We fear this book is not of much practical value. It speaks of the vast changes in many religious beliefs which have been brought about by more careful study and accurate investigation. But the writer forgets that this more accurate investigation applies no less to the Bible than to Nature around us, and while in one direction some old beliefs have been unseated, in another the value of the historic truths of the Bible has been made more certain.

AUTHORISED NEW TESTAMENT AND REVISED CONTRASTED. By B. Wadsworth. With the Translator's Preface to the Reader. Crown 8vo, pp. xxxvi—171. (Manchester: Brooke & Chrystal; London: Simpkin, Marshall, and Co. 1886.)

This is a severe attack upon the revised version, made by one who is no doubt sincerely attached to the old version as we have been accustomed to read it. We fear that his defence of the old and attack on the revised versions have been made without a thorough knowledge of the history of the original texts and the various MSS. That the revised version is faulty no one has shown more clearly than Dean Bergon, but the author does not appear to know where the real faults lie.

THEISM: The Baird Lecture for 1876. By Rev. R. Flint, D.D., F.R.S.E. Fifth Edition. Crown 8vo, pp. ix—447. (Edinburgh and London: William Blackwood and Sons. 1886.) Price 7s. 6d.

For those who have a taste for metaphysical subjects this book will be welcomed; indeed, we may add that the quiet perusal of it will do good to any one who can give real thought to its matter, though we must confess that its style is a trifle dry and unattractive. We would particularly commend the last chapter upon the insufficiency of mere Theism. It is a disadvantage—perhaps unavoidable in this case—that the Appendix is so lengthened out as to form one-fourth of the book itself. But these are all minor faults in the presence of the importance of the subject treated of.

POPULAR SONGS OF SCOTLAND, with their appropriate Melodies arranged by A. C. Mackenzie, J. T. Surene, T. M. Mudie, Finlay Dun, H. E. Dibdin, and Sir George A. Macfarren. Illustrated by critical and other notices. By George Farquhar Graham, author of the article MUSIC in the seventh edition of the Encyclopædia Britannica. New edition, revised, with additions and notes. Royal 8vo, pp. x.—401. (Edinburgh: J. Muir Wood and Co. London: Cramer, Chappell, Novello and Co. 1884.) Price 10s. 6d.

A splendid edition of Scottish Songs, which we can scarcely praise too highly. Many of the songs included in this work, although not often heard at the present date, are selected from the earlier collection known as "Wood's Songs of Scotland," and are considered worthy of a place here on account of their wit, quaintness, or the beauty of their melody. The historical notes accompanying each song add much to the value and interest of the work. The volume contains about 400 Songs and Melodies.

THE MEDICAL ANNUAL: A Record and Review of the year's progress in Medicine, Surgery, and General Science; and the Practitioner's Index: a Work of Reference for Medical Practitioners. (London: Henry Kimpton. 1886.)

In this year's Annual, which we notice is again considerably enlarged, attention has been given to a summary of recent advances made in Medicine

and Surgery, in which the editor had the co-operation of a number of medical men. The Review of Popular and General Science is by Dr. Taylor, the well known editor of *Science Gossip*. This is followed by Reviews of Therapeutics, the new Materia Medica, Phychological Medicine, etc. etc. The Practitioner's Index is edited by Dr. Percy Wilde. The whole work forms a most valuable year book.

Current Notes and Memoranda.

In addition to the Special Monthly Circular which we have regularly received from Mr. W. P. Collins, of 157, Great Portland Street, he has sent us his new Catalogue of Microscopical Literature, comprising almost every known work in MICROSCOPY, and a large selection of books relating to Micro Natural History, more particularly INVERTEBRATA and CRYPTOGAMIA.

Educators will be interested in the announcement that D. C. Heath and Co., of Boston, U.S.A., have in preparation a series of Monographs on Education. Number one of this series will be a *Bibliography of Pedagogical Literature*, carefully selected and annotated by Dr. G. Stanley Hall, Professor of Psychology and Pedagogics, John Hopkins's University.

The Biological Student will find the Syllabus of Instruction in BIOLOGY, by Delos Fall, of Albion College, U.S.A., a great help to them in a course of Biological studies. It gives instructions for the study of 16 type forms of animals, and a less number of plants, ranging in each case from the lowest to the highest forms. A large amount of instruction is compressed into 24 pages.

We learn from a newspaper just received from New Zealand, that the First Annual Meeting of the Auckland Microscopical Society was held April 1st. The Society appears to combine the double advantage of being a Postal and a Local Society. Boxes of Slides, after the manner of the P.M.S., are sent to members, and local meetings held during the winter. The Society was originated by Mr. Thos. Steel, late of Greenock, whose name is still on our books as a member of the P.M.S. We wish the Auckland Society every success.

John Weldon's Catalogue of Books, just received, contains a very large assortment of Zoological Works, comprising—Ornithology, Mammalia, Anthropology, etc.

The Annual Report of the BELFAST NATURALISTS' FIELD CLUB contains Reports of Excursions, Presidential Address, and several papers of much interest, among which is one by Dr. Malcolmson, on the Ostracoda of Belfast Lough, and another by the Rev. H. W. Lett, on the Fungi of the North of Ireland. Dr. Malcolmson's paper and several others are illustrated.

Messrs. Hammond and Co. inform us that they hope to publish the first part of STUDIES IN MICROSCOPICAL SCIENCE, Vol. IV., on the 10th July (instant).

THE JOURNAL OF MICROSCOPY
AND
NATURAL SCIENCE:
THE JOURNAL OF
THE POSTAL MICROSCOPICAL SOCIETY.

OCTOBER, 1886.

How Plants Climb.

By H. W. S. Worsley-Benison, F.L.S.,
Lecturer on Botany at Westminster Hospital; Late President of the Highbury Microscopical and Scientific Society.

TOWARDS the close of a paper on *The Power of Movement in Plants*, I briefly referred to this power as exhibited by many climbing plants. I then said that such movements came under the third or last class of the three which we then discussed—viz., *motion occurring in living parts of plants during active growth.*

I promised at some future time to say something more in detail concerning the various methods by which this climbing process is accomplished; this paper is an attempt, in some small degree, to redeem my promise.

That plants do climb, no one who takes an ordinary country walk, or sees the row of scarlet runners in his garden, or looks at a Virginia creeper, with its exquisite October hues, can for one moment question. How and why they do so, very few stay to enquire.

The student who is ignorant of the researches on this subject and of their results, leaves unread one of the most fascinating chapters in botanical romance. Prominent among such researches are those of Ludwig Palm and Hugo von Mohl in 1827, of Dutrochet in 1843, of Asa Gray in 1858, of Darwin in 1865, of Fritz Müller in the following year, and lastly of Hugo de Vries in 1873.

Although gathering information from each of these in part, I take as the chief groundwork of my paper Darwin's book entitled *The Movements and Habits of Climbing Plants*, which is now, with us, the acknowledged text-book on the subject. It is a small volume compared with most of his works, but none the less does it show the grasp and force of his mighty intellect. I can only give you a very few of the facts from which Darwin deduces the laws which govern the movements of the various classes of climbers—only attempt to lead you across the threshold of the 'Fairy Land of Science'—only go with you just through the gate which opens at our touch. You must for yourselves explore the field and search for treasure. The treasure is there, and much of it has been spread out to view, by the untiring, unceasing work of Charles Darwin, for those who have eyes, and use them for their right and reasonable purpose.

Darwin divides climbing plants into four Classes, as follows:—

I.—Twiners.—Those which *twine spirally* round some support, unaided by any other movement.

II.—Climbers.—Those ascending by the aid of *sensitive or irritable organs*, which, touching an object, clasp it. This Class is further separated into two Divisions, graduating to some extent into each other:

A.—Leaf-Climbers.—Those retaining their leaves in a functional condition, and climbing by either their *petioles*, or their *produced mid-ribs, or tips ;*

B.—Tendril-Bearers.—Those having true *tendrils*, these being filamentary sensitive organs, consisting of modified *petioles*, *leaves*, *flower-stalks*, or *stipules*.

III.—Hook-Climbers, or Scramblers.—Those climbing simply by the aid of *hooks*.

IV.—Root-Climbers.—Those ascending by means of *rootlets* attached to their supports.

Let us take the classes in the above order, and ascertain the manner in which each set of climbers pursues its way by studying a few examples.

I.—Twiners. This is the largest class, and for several reasons appears to be the oldest and simplest type.

Darwin takes *Humulus lupulus*, the common Hop, as a fair example. Its first two or three internodes are straight and quite stationary. Then comes one that, while young, bends over to one side, and travels slowly round its support in the direction of the hands of a watch; as the next internode is developed, the two rotate, and usually a third. The ordinary velocity is soon attained, and this was found to be about 2 h. 8 m. for each revolution. As the lowest internode grows old, it gradually ceases to rotate, although the revolutions continue in the terminal two or three of the shoot, so long as the plant continues to grow. Thus, internode by internode, the shoot twines itself round its support, each 'joint' of the stem gradually becoming stationary, while the last two or three keep up the revolving motion, until the final internode, or tip, ceases to move. In most plants, Darwin found that three internodes were revolving at the same time, but in every case at least two were at work, "so that by the time the lower one ceased to revolve, the one above was in full action, with a terminal internode just commencing to move." A Hop-shoot with three internodes revolving was carefully watched. It was 14 inches long, and at such an angle to its support that its tip swept a circle of 4 ft. 9 in. This it did in 2½ hours, giving an average movement of 23 inches an hour. With another plant, one of the *Asclepiadaceæ*, a shoot consisting of five internodes, measuring altogether 31 inches, described a circle of 16 ft. 6 in. in 6 hours, giving an average speed of 33 inches an hour.

The rate of revolution varies widely in different plants. The shortest periods for one revolution ranged from 1 h. 40 m. in the white Convolvulus to 18½ hrs. in an exotic plant (*Sphærostema*). The rate by night or by day differs but little. Vigorous health and moderate warmth favour the movement. The twining *Poly-*

gonum does its work only during the middle of summer; it grows vigorously in autumn, but with no tendency to climb.

With regard to the direction which the revolving movement takes, there are very many interesting facts. We can only notice at present that some twine from left to right, or against the hands of a watch, while others take the opposite direction. These terms are used in different senses by different writers. The simplest and best method to clearly apprehend the terms is to imagine the pole, or support *in front of the observer*, and then to note in which direction the first revolution is made. If it be from right to left—*i.e.*, with the watch—it is called *sinistrorse*; if from left to right, it is *dextrorse*; the terms being used to specify the hand *towards* which the shoot twines.

By far the greater number of twiners revolve from left to right, dextrorsely; the purple and white Convolvuluses, French bean, and Morning Glory are examples. A few take the opposite direction, as, for example, Hop, Honeysuckle, and Black Bryony (*Tamus*). Very rarely do plants of the same order twine in different directions. Darwin met with no two species of the same genus that did so, but different individuals of the same species are sometimes found to twine in two ways: the Woody Nightshade (*Solanum dulcamara*) of our hedges, for example. In some cases, as in the Chili Nettle, some individuals twine in one way, some in the other, others in both, the petioles of its opposite leaves affording a fulcrum for the reversal of the spire. This double movement in the same plant is rare. It occurs in *Hibbertia*, where the twining is always dextrorse, while the revolving movement varies; thus the plant is adapted for twining in order to ascend, and at the same time is able to wind from side to side through the thick Australian scrub.

Our indigenous twiners can ascend a support as thin as ordinary thread, some, such as Woody Nightshade, being able to climb *only* round very thin and flexible stems; they can ascend stems of moderate thickness, but Honeysuckle is the only one that ever twines around tree-trunks. In the tropics, on the contrary, twiners can ascend forest-trees, and this is needful for them, or they would be unable to reach the light and air. In England, our annual twiners would be unable in their single season to reach

so high as the level of our forest tree-tops, so they select smaller and shorter supports in other situations.

The main purpose of plants becoming climbers in any way is, of course, to reach such a position as to enable them to expose their leaves to the action of air and light, with as little expenditure of matter as possible. In the case of twiners, their first step is to *find* some support on which they can rely, towards the attainment of the end in view. It is *in order to find such support* that the spontaneous revolving movement is carried on by day and night, the shoot sweeping in wider and wider circles. This shows us how the plant twines, for when a revolving shoot meets with a support, this support of course arrests the movement at the point of contact, while the free portion continues revolving. Thus higher and higher parts are one by one arrested, and the shoot winds round its support. Such is Darwin's own explanation.

How is the revolving movement effected? It was formerly supposed that it was wholly due to a twisting of the shoot or stem on its own axis. This is now conclusively disproven, for many plants clearly revolve, especially among leaf-climbers and tendril-bearers, and yet their internodes are in no way twisted. We also meet with instances where different internodes are twisted in opposite ways, and even in an opposite direction to that of their revolutions. The axial torsion seems rather to bear relation to ruggedness or inequalities of the support, and to the power of revolving freely without any support.

Nevertheless, seeing that although many plants, not being twiners, are axially twisted, and that this tendency is much stronger and more frequent in plants that do twine, it is probable that there is some relation between the power to twine and the presence of their axial twisting.

The revolving movement is effected as follows:—It is a successive *bowing over of the stem*, first in one direction, then in another, and so on, until a circle has been completed—*i.e.*, the stem is *pulled over*, so to speak, by some internal force, acting in turn *all round* the stem in the direction in which it is sweeping, so that the circuit is made without any real twisting. This is not easy to explain in words, but suppose we paint a dotted line along the upper or convex side of a shoot bent towards the South. Let

it move round a quarter of a circle, say to the East: the dotted line will be on the *side* of the shoot facing the North; move the shoot another 90 degrees, *i.e.*, to the North: the dots are on the under or concave surface; when the shoot points West, the dots again appear on the side; bring it round South again, and the dots appear once more on the upper or convex surface. No twisting has taken place, but the shoot has completed its circle of sweeping, and this by successive bowings over of itself in the direction of its revolving movement.

Now, let us substitute for the dotted line on the convex surface, a very much more rapid growth of the cells on *this surface* than on the other three, preceded by turgescence of the cells. This unequal increase of growth would cause the shoot to bend down in the opposite direction, making the Southern side concave—in other words, it effects the bending of the shoot to the South. Now, let this turgescence and unequal increase of growth creep round the shoot (just as we made the dotted line to twist round it) in successive stages, until it has gone the entire round of the shoot. As it travels, it causes each part of the circumference to bend or bow to the opposite side, the result being that the shoot gradually sweeps in an entire circle round the support, the circumference of the circle being dependent on the length of the shoot and its inclination to the support.

In this, we have the true explanation of the revolving movement, or, as it is now termed, *circumnutation.* I referred to this same process of turgescence, succeeded by unequal growth on one side, when describing the phenomenon of Heliotropism. A similar process explains the folding of young leaves over the end of their stem, and their subsequent unfolding, the under surface suffering increase of growth in the former case, the upper surface growing more rapidly in the latter.

The circumnutation of twining-plants is simply the ordinary circumnutation of the stems and roots of seedlings, and of leaves in general, *modified by being increased in amplitude.*

The power is innate, and is not excited by external agencies, beyond those necessary for growth and vigour. The process itself once clearly understood, the revolving movement of climbing-plants is no longer the mystery it was before.

We pass now to our second Class. This consists of plants climbing by means of sensitive or irritable organs, which, touching any object, clasp it in some way or other. These are—

II.—CLIMBERS. We divide this class into two groups for convenience' sake :—

A.—LEAF-CLIMBERS.

B.—TENDRIL-BEARERS.

In some cases these shade the one into the other.

A.—LEAF-CLIMBERS.

These are intermediate in some respects between twiners and tendril-bearers. They climb in two ways; some by means of their *petioles*, and others by their produced *mid-ribs*, *or tips*.

In nearly all the species examined by Darwin, the young internodes showed a revolving power, in some cases quite as regular as in a twining-plant; in most cases the revolutions were rapid.

The purpose of the revolving in these leaf-climbers is not to climb around a support, but to enable the leaf-stalks, or the leaf-tips, as the case may be, to get near to some object which they can clasp. Of course this power of revolution greatly assists the plants in making use of their sensitive organs.

As in true twiners, the first internodes do not revolve, nor do the petioles or tips of the earliest formed leaves appear to be sensitive.

There are some eight orders in which we find leaves with clasping *petioles*. Prominent among these are sundry species of *Clematis*, *Tropæolum*, *Solanum*, and *Fumaria*. In many of these there is a tendency to revolve in opposite directions, thus differing from true twiners. They are, of course, inferior twiners.

The petioles are enabled to clasp any object in virtue of *an extreme sensitiveness to touch*. On being touched, or rubbed, they bend towards the irritating object, or towards the point of irritation. If they find a twig or stalk of any kind, they grasp it, sometimes taking two or three turns round it. If they find nothing to hold by, they gradually uncoil and straighten themselves again; in this position they remain permanently.

In some species, the young leaves spontaneously shift their position—*i.e.*, without any external stimulus; their petioles

gradually bend down until at right angles to the stem; remaining there for a time, they arch downward until the leaf points to the ground with its tip incurled. This is their fashion of looking out for a support, which the revolving motion of the shoot may bring them near to. They then act as I have just indicated, according to whether they find the support they seek, or fail to find it.

A petiole coming into contact with a support for a short time only, usually continues curved for some time, but can afterwards regain its upright position, and so be ready to act once more; but if it clasp its support for any length of time, then it cannot straighten again. In some species, markedly so in some of the *Clematis* family, the petiole having coiled around its support, in two or three days begins to swell, and gradually thicken, either laterally, or through its whole diameter, until it becomes twice as thick as an unclasped petiole. It then becomes much more woody internally, like a stem, and instead of being easily snapped in two, it is so tough and rigid that force is needed to break it.

This change of structure gives greater durability, firmness, and strength; it hinders the unwinding of the petiole, and of course enables it to withstand the force of the wind, or of shock from any other cause. The appearance of a cross-section of such a petiole under the microscope, shows a *complete ring* of woody tissue, as opposed to the semi-lunar one of an ordinary leaf-stalk. It is a fact worthy of note that this change is effected merely by the act of clasping a support.

Petioles are usually sensitive only when young. They are sensitive on all sides, although this differs in different species.

The rate at which they respond to a touch varies. In some species of *Tropæolum* a slight rub took effect in three minutes; in others the response occupied six, ten, or even twenty minutes. In other cases—for instance, in some species of *Clematis*—it took several hours. In others, two or three days or more pass by before the process is complete.

The degree of sensitiveness varies. In some, a weight of only one-sixteenth of a grain will cause bending to ensue; in others, the touch of the exceedingly fine flower-stalks of the Quaking-grass (*Briza*).

This sensitiveness extends in some cases to the stems and to

the flower-stalks. In the latter case the reason is hard to find, since no use is made of this property for climbing purposes.

Four families exhibit the power of climbing by their produced *mid-ribs, or tips.*

Two notable cases are *Gloriosa*, a genus of *Liliaceæ*, and *Nepenthes*, the Pitcher-plant.

In *Gloriosa*, the tip of the leaf grows into a ribbon-like projection, which gradually coils down into a well-formed hook. Only the inner or under surface in this case is sensitive to touch. If the hook becomes coiled into a ring it loses its sensitiveness entirely. When very young the plant can support itself, and no hooks are developed ; when it has done growing the sensitiveness vanishes. In neither case are the hooks needed ; therefore, they are either absent or their sensitiveness departs.

In *Nepenthes*, the curled tip of the leaf is used both for climbing by, and as a support for, the pitcher. The coiled portion in the latter case is, nevertheless, thickened by way of providing additional strength.

B.—TENDRIL-BEARERS.

These are plants having true tendrils—*i.e.*, thread-like sensitive organs, which are used exclusively for climbing. We do not in this definition include spines, hooks, or rootlets.

Tendrils may be modifications of *petioles*, *leaves* (or portions of leaves), *flower-stalks*, or *stipules.* Sometimes the *branches* are so modified as to become tendrils. In some cases authorities are in dispute over the homological nature of certain tendrils. These we shall do wisely to let alone, confining our remarks to such tendrils as those whose homology is pretty clearly made out.

I can only in such a paper as this give the merest outline of the facts and functions of tendril life—a sketch of the more prominent and interesting points, referring the reader to pages 84—182 in Darwin's book for fuller detail, pages well worth diligent study and verification.

1.—*Tendrils which are modified Petioles.*

Of these a good example is that of *Lathyrus*, the Yellow Vetchling. There are no true leaves, their places being functionally supplied by large stipules. The petiole, or perhaps this and the mid-rib as well, is converted into a true tendril, sensitive

chiefly on the concave side at the end. It does not revolve, but the young internodes do so, carrying the tendrils with them.

2.—*Tendrils which are modified leaves.*

Several orders contain examples of this type of tendril. A familiar one is *Pisum sativum*, the common Garden Pea. Here the leaf has a few pairs of leaflets, one or two pairs of tendrils, and a terminal one, often branched—*i.e.*, some lateral leaflets and the terminal ones are changed into tendrils. The young internodes and the tendrils revolve in ellipses. The motion in this case is independent of light, the latter neither retarding nor quickening it. When young the tendrils are sensitive to so small an irritant as a loop of thread one seventh of a grain in weight—*i.e.*, on their concave surface only.

Many other examples could be quoted. The *Bignoniaceæ*, or Trumpet-flower Order, furnish perhaps the best. Darwin made extensive researches on many species of *Bignonia*, which I cannot stay to quote now. Some species have tendrils with claws like those of a bird, highly sensitive, and capable of such firm grasping that Darwin says these species could probably ascend a highly polished stem, even when tossed by storms. The claws end in hooks, which, of course, increase the power of the grip. *Bignonia Tweediana* can twine, has clasping petioles as well as hooked tendrils, and moreover presently emits aërial roots from the bases of its leaves, which curl round the support. It thus very curiously unites four different movements of climbing plants, viz., twining, leaf-climbing, tendril-climbing, and root-climbing.

"One species climbs by spirally twining and then by grasping the stick with opposite tendrils alternately, like a sailor climbing a rope, hand over hand. Another pulls itself up like a sailor seizing with both hands together a rope above his head." Others develop an instinct for inserting the sharp ends of their tendrils into chinks and crevices of wood, or any other support which may possess these, sometimes prying into one hole, and, finding it not to its liking, seeking another! In *Bignonia capreolata*, after the tips had crawled into the crevices, or the hooked ends had seized on a projecting point, the tips began to swell for two or three days, and then to form whitish balls or discs, one twentieth of an inch in diameter. These secreted a viscid matter, which would

firmly glue together 50 or 60 fibres of flax or wool in a mass. This power is used naturally by this species to fasten itself to the forest-trees of North America, which are covered with mosses, lichen, and other rugged and rough organisms.

3.—*Tendrils which are modified flower-peduncles.*

Excellent examples of such tendrils are seen in the Vine, the Virginia Creeper, and the Passion-flower. The first two belong to one order, the *Vitaceæ.* In these the action is much the same as in the cases of tendrils which are modified leaves

In the Vine the tendril is two-branched, one branch always having a scale at its base. Rubbing causes the branches to bend, but they will afterwards become straight again. A tendril clasping any object contracts spirally. Of this, later on. There is clear spontaneous movement in the tendrils. We can trace every single stage of gradation from the state of flower-stalk to that of a true tendril; from one bearing 30 or 40 flower-buds even to a full-sized perfect tendril bearing one flower-bud! Hence we cannot question the nature of the tendril in the Vine. Where the flower-stalk and the flower-tendril exist together, the latter is always at such an angle with the former that it assists later on in carrying the burden of the fruit.

In the Virginia Creeper there is no revolving of either internodes or tendrils; only a movement away from the light to the dark, a process seen in several tendril-bearers. The tendrils are specially adapted for attachment to a flat wall or other surface by bringing their hooked tips into contact with it. These then develop the well-known discs or cushions of a bright-red tint. These undoubtedly secrete a viscid fluid, inasmuch as they can cling to smooth polished surfaces, such as an Ivy-leaf or painted wood. Warm water with dilute acetic acid and alcohol will not loosen any flinty particles that may have become attached to the discs, but warm, essential oils will loosen them entirely, pointing to a resinous fluid as the one secreted. Discs are not developed except under the stimulus of contact. The attached tendrils contract spirally; unattached ones do not, but in time shrivel up and drop away. The spirally-contracted tendril becomes very elastic. At first it is brittle and weak, but soon acquires strength and increases in thickness. It dies during the next winter, but

adheres firmly, although dead, to the wall and to its own stem. Such tendrils will remain like this for 5, 10, or 15 years! Darwin found that a single disc-bearing branch would bear a strain of two pounds; a whole tendril, usually carrying five branches, would therefore endure a strain of ten pounds!

Of the Passion-flower I can only say that *Passiflora gracilis* was found by Darwin to exceed all other climbing plants in rapidity of action, and all tendril-bearers in the sensitiveness of its tendrils.

4.—*Tendrils which are modified Stipules.*

I simply name one case—*Smilax aspera*—where this occurs. Their position places the matter beyond doubt. As they grow they diverge from each other, and are thus enabled to clasp an object *behind* the stem. They avoid the light, and do not spirally contract. Neither they nor their internodes revolve. *Smilax* is in all respects an imperfect climber. There are no tendrils in the young state; the stem is zigzagged and furnished with spines, growing only to some eight feet high. The reason of the existence of these tendrils is not easy to explain. Darwin regards it as a kind of degraded relic of a genus formerly possessing highly organised tendrils, seeing that even now some species have much longer ones than *S. aspera*.

A few isolated and brief remarks on tendril-life as a whole must close our somewhat rambling study of this class. In most tendril-bearers the young internodes revolve in ellipses, varying in rate from one to five hours, a smaller range than that of twiners. Twining power is almost *nil*, but the revolving motion serves to aid the tendrils in finding support. Tendrils themselves revolve spontaneously in most cases, sometimes *with* the internodes, sometimes at slower speed; some do not revolve—*e.g.*, *Lathyrus*, as we saw just now. In one case—the Virginia Creeper—neither internodes nor tendrils revolve.

Tendrils revolve by curving of the whole length, except the base and tip. The movement is due to unequal growth travelling round the tendril and bowing it, a process we saw before in the twining stem. To this cause is due not only revolution, but movement to and from the light, and spiral contraction.

Darwin thinks that motion following touch in tendrils is due to

contraction of cells on the concave side ; a point on which he differs from Sachs, who attributes this motion, as well as all others, to the unequal growth spoken of.

Tendrils, when revolving, manage, in a way very wonderful to see, to avoid clasping the stem to which they belong (Gray).

All tendrils are sensitive, the degree, of course, varying. They curve towards the side touched. Usually they are not sensitive to the touch of other *tendrils*, or of *water-drops*. Has the latter fact anything to do with their relation to showers of rain ?

Some tendrils are retarded in their movement by light, others quickened ; others, as those of the Pea, not influenced at all. In some the invariable bending from light to dark is as certain as that of a vane from the wind.

Tendrils contract spirally when their ends are caught by any object. This shortens them, and renders them elastic. This spiral contraction is almost without exception ; it may ensue in the branches only, as in the Pea ; in most cases, the base does not contract.

It is due to unequal growth. It is independent of revolving motion, and not necessarily related to the act of clasping, since many tendrils unattached perform this act either as a helix or as a spire *(Passiflora)*. In this case there is only *one* spire formed, but in attached tendrils the spire is always double and reversed, with a straight part between the two spires. There is, of course, a simple physical reason for this, into which I cannot now enter more fully. ("Climbing Plants," pp. 166—169.)

For a summary of the use and service of contraction, I refer the reader to Darwin's own words ("Climbing Plants," pp. 163, 164).

III.—Hook-Climbers.

Examples are seen in *Galium aparine*, Brambles, and some Roses. There is no revolving power, the plants climbing solely by the hooks. *Smilax* and Hop, belonging to former classes, have hooks.

IV.—Root-Climbers.

Of these, Ivy is a very good type. *Rhus*, or Poison Ivy, is another. *Ficus repens*, a species of Fig, emits drops of viscid fluid to assist its upward progress. *Cuscuta* (Dodder) has root-like suckers used for a similar purpose.

Sutton, Surrey; July, 1886.

Notes on the Identification of Alkaloids and other Crystalline Bodies by the aid of the Microscope.*

By A. Percy Smith, F.I.C., F.C.S.

Plates 21, 22.

THE number of cases in which a crystalline substance can be identified by the microscope alone is extremely limited; but as a test of purity, microscopical investigation has a very wide application. When we are dealing with a substance that, when pure, crystallises in a definite form from any particular solvent, it is manifest that any departure from that form would lead to the suspicion of adulteration.

Again, if we take such a substance as bark, or opium, it is quite possible to distinguish from each other the various alkaloids which it contains. Besides the form assumed by the free base, it is of importance to convert it into a salt, as there is frequently a marked departure in the form of the crystals—*e.g.*, quinidine and quinidine sulphate; cinchonidine and cinchonidine sulphate. There may be cases in which the salt and the base possess the same crystalline form. I have recently met with one in cocaine, which, as well as the hydrochlorate, crystallises in long needles radiating from a central nucleus, aggregated at angles of 90°, 180°, 270°, and 360°.

Some experience is necessary in selecting the most suitable solvent from which to crystallise an alkaloid, as the duration of the evaporation may have a marked effect upon the form of the crystals. In some cases, evaporation may be accelerated by the aid of heat; in others, such a proceeding is fatal to success. The addition of alcohol to ether, and of water to alcohol, appears to be the best means of retarding the process when necessary. To take the case of cocaine. From chloroform no crystals are deposited. From ether they are ill defined, but from alcohol, allowing evaporation to proceed very slowly, we get the best results.

I always employ polarised light by which to view the crystals,

* From the *Analyst*, by permission of the Editor.

either with, or without, the addition of a selenite plate. Here again, the duration of evaporation has a marked effect, also the strength of the solution. If the substance is deposited in a thin film, it may be altogether invisible without polarised light. Thick crystals frequently produce colour without the selenite, and those that are very thick may depolarise without any colouration. This being borne in mind, no difficulty is experienced in practice, as it is easy to compare with an alkaloid of known purity crystallised under the same conditions.

In the accompanying plates, I have endeavoured to give a representation of various substances crystallised under the best conditions, with the name of the solvent and the linear magnification. The letter *B* signifies a black field (ordinary polarised light) and *V* a violet field produced by the selenite. In many cases, I have found it difficult, if not impossible, to give a faithful drawing, but that is of slight importance, since anyone who makes use of this method would naturally prepare his own slides for comparison.

Bark.

Quinine deposited from alcohol is granular.

Quinine Disulphate crystallises from alcohol in a network of fine needles.

Quinine Disulphate mixed with a little iodosulphate is a gorgeous object, either with or without the selenite. It appears like an assortment of peacocks' feathers with the crests towards the centre.

Quinine Disulphate mixed with quinidine sulphate forms little feathery crystals totally distinct from either of the salts crystallised alone.

A mixture of quinidine, cinchonidine, and cinchonine will not crystallise at all from alcohol, but dries up to a gummy mass.

Quinidine crystallises from etherial alcohol in stellate groups of monoclinic prisms, giving red centres and green at the ends (Fig. 1).

Quinidine Sulphate has an entirely different form, each crystal assuming an independent hue (Fig. 3).

Cinchonidine crystallises from alcohol in globular tufts of needles

and in stellate groups, some of which exhibit a black cross on a white ground, resembling *somewhat* the grains of tous-les-mois; the larger groups show some colour (Fig. 2).

Cinchonidine Sulphate exhibits a marked change into pure colourless feathery sprays (Fig. 4).

Cinchonine.—The crystals of this alkaloid, deposited from alcohol, are small, and resemble those of caffeine. The arrangement is, however, different. They are grouped in stars.

Opium.

Morphine crystallised from alcohol in minute needles (trimetric). They are characteristic and show *faint* colouration (Fig. 5).

Meconic Acid forms micaceous scales or small rhombic prisms, and is a unique object; the most usual form is a square with elongated corners, thus producing curved sides. The colouration is very varied: one may be like the French tricolor, another *quartered*, another showing two hues parted by a median line (Fig. 6).

Meconine crystallises from water in a network of long needles, which are very large and of all conceivable colours (according to Watts, they are hexagonal prisms) (Fig. 9).

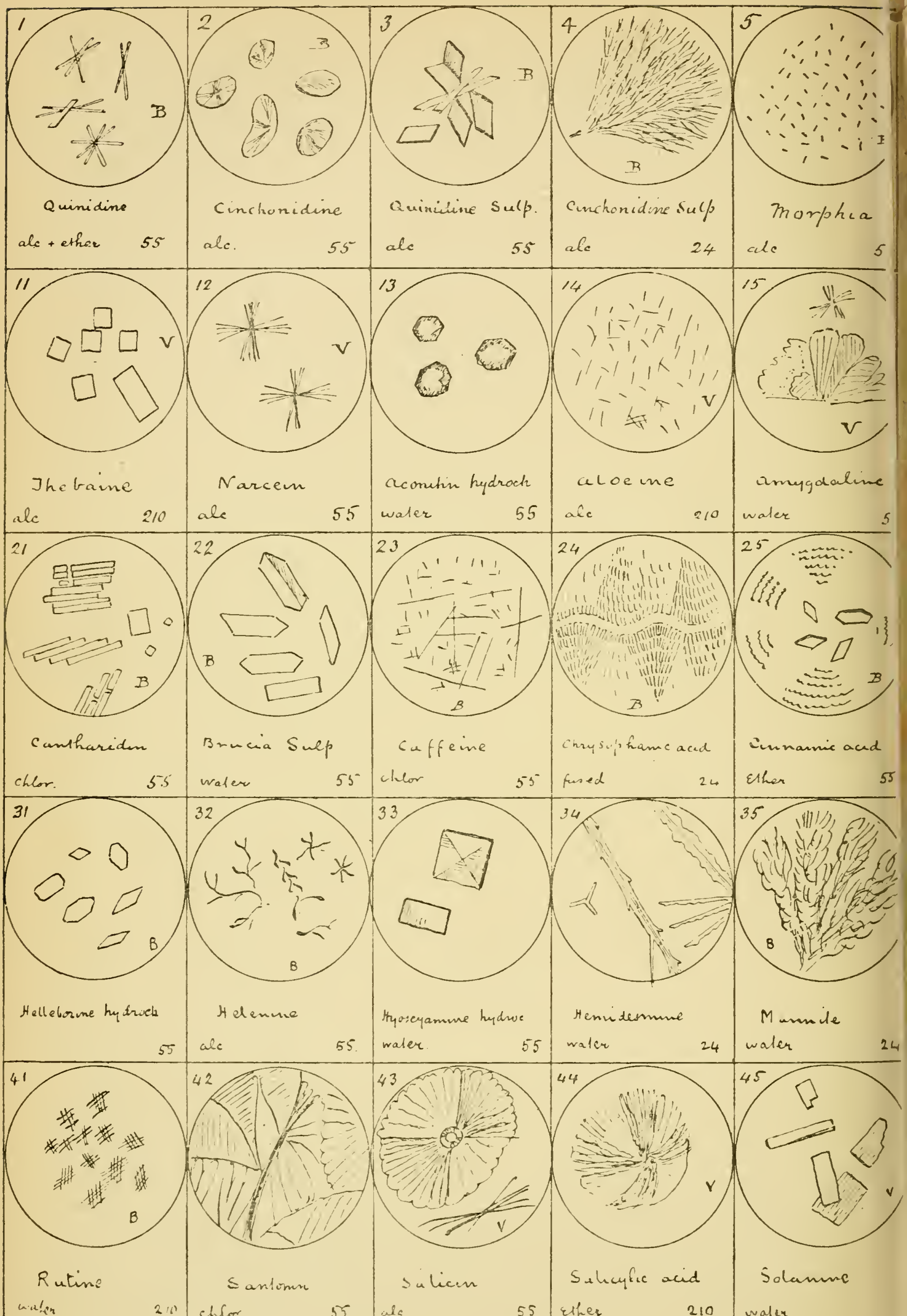
Narcotine separates from alcohol in separate crystals, each an independent hue (Fig. 7).

Codeine crystallises from alcohol in large rectangular octohedra, truncated and modified in various ways. Also in a network of prisms, and other modifications. The selenite makes very little difference to the large crystals, as they are too thick to be affected by it (Fig. 8).

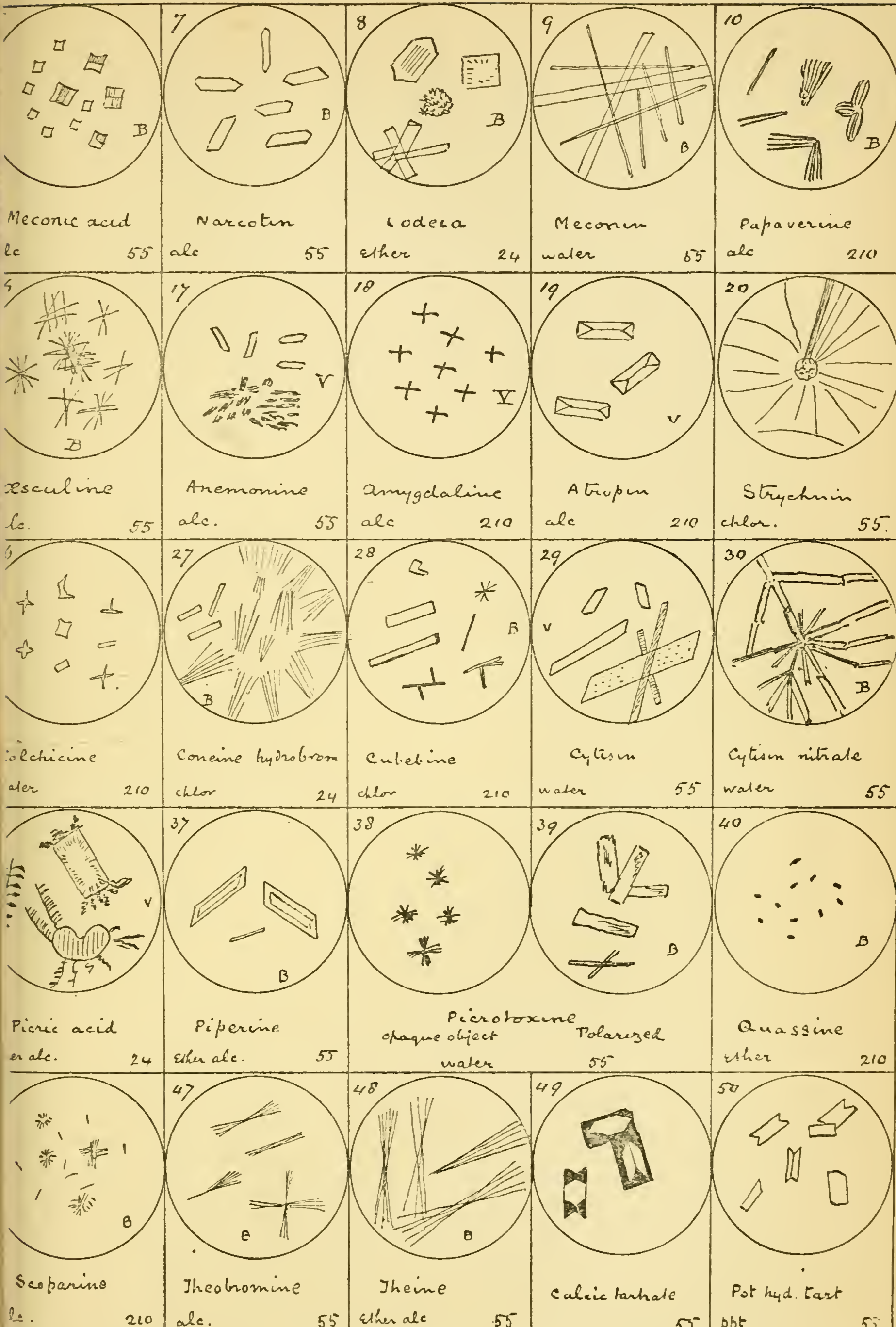
Papaverine.—The crystals deposited from alcohol have a great tendency to arrange themselves in globular stars. Between these are seen badly-formed prisms, generally four or five together, star-wise. They are coloured (Fig. 10).

Thebaine.—The crystals are very similar to those of elaterine, but are larger and better defined. They are square plates, and show no colour without the selenite (Fig. 11).

Narceine forms stellate groups of needles, which require the



MICRO-CRYSTALS.



MICRO-CRYSTALS.

selenite to show colour. Then the horizontal and vertical needles assume complementary tints (Fig. 12).

An attempt was made to identify meconic acid by the above method, after extracting from an organic mixture, to which opium had been added, and which was successful. The process employed was as follows:—

Boiled with alcohol and a little HNO_3, filtered, added water, distilled off alcohol, precipitated the meconic acid with Pb Ac_2, decomposed with H_2 S, evaporation to dryness, and crystallised from alcohol.

The filtrate from the lead meconate was shaken with benzine, and the benzine residue crystallised from water and from alcohol. Long needles of meconine were easily recognised.

The benzine extract from the liquid made alkaline, and the chloroform and amyl alcohol extract all yielding crystals, but they could not be recognised. All contained meconine.

Aconitine does not crystallise from either alcohol, water, or petroleum ether. Its hydrochlorate crystallises with great difficulty from water. A very lengthy evaporation is requisite. The plate shows the crystals viewed by ordinary light, without the polariser (Fig. 13).

Aloeine crystallises from hot alcohol in small *yellow* needles, grouped in tufts, which depolarise very slightly. It may be viewed either as a transparent or opaque object. The plate shows detached crystals, seen with selenite (Fig. 14).

Amygdaline differs in appearance, according whether it is crystallised from alcohol or from water. From the latter, it forms large, feathery crystals, like the distended tail of a bird, and gives fine colours with the selenite. From alcohol, it forms small, ill-defined stars, the components of which exhibit complementary hues (Figs. 15 and 18).

Œsculine forms colourless needles, in stellate groups (Fig. 16).

Anemonine crystallises from hot alcohol in moss-like forms, which depolarise completely, but give no colour without the selenite. There are also some isolated crystals belonging to the trimetric system. (Decomposed into anemonic acid by boiling with alkalies) (Fig. 17).

Atropine is best crystallised from alcohol, when it forms a confused mass of prisms, each of an independent tint. Where the film is thin, it forms fan-shaped crystals. Without the selenite, the crystals merely appear a bluish white (Fig. 19).

Strychnine crystallises from alcohol in long prisms; from benzine in polygonal plates, or six-sided prisms, not constant; from ether in dendritic forms, and sometimes prisms. Deposited from chloroform, the appearance is highly characteristic, forming rosettes, and various forms of great beauty. I have made no attempt to delineate the rosette with any approach to accuracy, as it is scarcely possible to copy it in pen and ink. It is probably too familiar to my readers to need description. I have succeeded in obtaining a film of strychnine, quite invisible with ordinary illumination. On introducing the polariser, dark circular forms and ridges are made visible. When the selenite plate is added, the most gorgeous colours are obtained.

I regard the appearance of strychnine as so characteristic as to obviate the necessity of using chemical tests. I have frequently extracted the alkaloid from organic mixtures, and identified it in this way without the trouble of purification from dirt. Of course I presuppose the absence of other substances that can enter into combination. There is only one other alkaloid that can, *by any chance*, be mistaken for strychnine, and that is santonine; but, in following Dragendorff's scheme, they would be extracted by different solvents. Besides, there is a considerable difference in the appearance when carefully examined (Fig. 20).

Cantharidine crystallises from chloroform and from alcohol in right-angled four-sided prisms. Those crystals which depolarise without colour give clear tints with the selenite, showing the evenness of their surfaces. There is a tendency to form stars; the larger crystals are coloured without the aid of the selenite. The appearance is quite characteristic and can be confounded with no other alkaloid I have as yet examined (Fig. 21).

Brucine Sulphate is best crystallised from water. The crystals depolarise chromatically without the selenite. The free base

does not crystallise so well (Fig. 22).

Caffeine crystallises from chloroform in a network of needles. The crystals are thicker in the middle than at the ends. For the most part they are brilliantly white, but some of the larger show colour on account of their greater thickness. When the selenite is used each crystal assumes an independent tint (Fig. 23).

Chrysophanic Acid is most characteristic when fused in a thin film, and allowed to solidify, when it forms moss-like aggregates of laminar crystals which depolarise, retaining their yellow colour (Fig. 24). It crystallises in six-sided monoclinic prisms from benzine.

Cinnamic Acid crystallises from ether in perfectly formed monoclinic prisms of varying hues. If the solution be too concentrated the crystals set in a mass, showing no colour, but arranging themselves in concentric waves (Fig. 25).

Colchicine crystallises with extreme difficulty from water. The varnish-like residue left on evaporation, if kept in a dry place, will ultimately show the crystals at margin (Fig. 26).

Coneine Hydrobromate crystallises from chloroform in white needles (Fig. 27).

Cubebine.—The best solvent for cubebine is chloroform, but the crystals do not depolarise well, and are best viewed as transparent objects (Fig. 28).

Cytisine is soluble in water and dilute alcohol, but not in ether, chloroform, benzol, or bisulphide of carbon. It crystallises well from water, and, when the selenite is used, each crystal is of an independent tint. Where the crystals cross each other at right angles complementary tints are assumed (Fig. 29).

Cytisine Nitrate crystallises from water in branched prisms of very variegated hues. It is a very pretty object (Fig. 30).

Digitaline.—I have been unable to obtain this alkaloid in a crystalline form.

Elaterine deposited from chloroform is precisely similar in form to Thebaine (q.v). The crystals are somewhat smaller, and require a power of 210 diameters. With the selenite, each

crystal is an independent tint (see Fig. 11).

Helenine can scarcely be said to crystallise at all. The alcoholic residue refuses to dry completely at ordinary temperatures. The crystals are mere arborescent sprays (Fig. 32).

Helleborine crystallises as the hydrochlorate from an acid solution, by dissolving helleborine in HCl and allowing it to evaporate spontaneously. The crystals are white under polarised light (Fig. 31).

Hyoscyamine crystallises as the hydrochlorate from water. The crystals are best viewed by ordinary light, and resemble crystals of common salt (Fig. 33).

Hemidesmine crystallises from water in needles of a peculiar shape —spiked, branching, and flattened (Fig. 34).

Mannite crystallises from water in feathery sprays, resembling those of cinchonidine sulphate, q.v. (Fig. 35).

Picric Acid.—The crystals of picric acid deposited from etherial alcohol are yellow by reflected light, but under the polariser present most remarkable forms. The crystals are rectangular and fringed with the most curious arborescent processes. Some forms resemble moss, others branches of fir. Altogether it is a unique object. Best seen with selenite (Fig. 36).

Piperine crystallises well from a mixture of alcohol and ether, in four-sided monoclinic prisms. The crystals appear as if marked upon their surface, owing to the varying thickness, or partial adherence of other crystals (Fig. 37).

Picrotoxine, both from alcohol and water, forms ill-defined crystals (four-sided prisms) grouped in stars. These, for the most part, do not depolarise because they are globular in form, and, consequently, nearly opaque. A few isolated crystals depolarise (Figs. 38, 39).

Quassine forms very minute crystals when deposited from ether. I am not quite certain to what system they belong. A power of 210 is not sufficient to determine this (Fig. 40).

Rutine crystallises from hot water in a network of fine needles (Fig. 41).

SANTONINE when crystallised from chloroform bears a faint resemblance to strychnine. It forms large feathery rosettes which differ from those of strychnine in possessing a crystal for a nucleus. Like strychnine the films show no colour without the selenite (Fig. 42).

SALICINE crystallises from alcohol in long needles, rosettes, and feathery tufts, and forms a striking object with the selenite. The rosettes are coloured complementary in a cruciform direction, and the nucleus is also complementary in the opposite direction (Fig. 43).

SALICYLIC ACID crystallises from ether in rosettes somewhat resembling those of salicine, but the nucleus is a point, and not a circle, as in the latter. It forms an exceedingly pretty object with a low magnifying power (Fig. 44).

SOLANINE is sparingly soluble in water, and crystallises therefrom. It is soluble in alcohol, but does not then crystallise. Viewed with the selenite, each crystal assumes an independent tint (Fig. 45).

SCOPARINE.—The only method of obtaining crystals is to dissolve in AmHo and precipitate with HCl, when the crystals are seen immersed in a jelly, or by dissolving in hot alcoholic ammonia and allowing to cool very slowly (Fig. 46).

STYRACINE crystallises from slow evaporation of etherial or alcoholic solution in arborescent forms.

THEOBROMINE is by no means a show object for the polariser; the crystals are very bushy, and not sharply defined like those of theine (Fig. 47).

THEINE crystallises from etherial alcohol in long needles, an aggregation of imperfectly formed stars (Fig. 48).

CALCIC TARTRATE.—If calcic citrate, which is not crystalline, be contaminated with the tartrate, it may be easily detected by aid of the microscope (Fig. 49).

POTASSIC HYDRIC TARTRATE.—The plate shows the crystals as precipitated from potassic chloride by sodic di-hydric tartrate (Fig. 50).

Experiment with a Mixture of Alkaloids.

In order to subject the microscopic method of identification to a severe test, the following mixture was made :—

Morphine, Narcotine, Codeine, Narceine, Papaverine, Thebaine, Meconine, Meconic Acid, Cinchonine, Cinchonidine, Quinidine, Quinine Sulphate, Atrophine, Brucine Sulphate, Strychnine, Santonine, Cantharidine, Theobromine, Theine, Piperine, Salicine, Picrotoxine, Coneine, Hydrobromine, Aloeine, and Picric Acid.

This was treated *à la* Dragendorff.

The petroleum ether extract from an acid solution was recrystallised from ether, and yielded crystals recognised as those of Piperine and Picric Acid.

The Benzole extract from the acid solution was recrystallised from ether and from chloroform, and yielded crystals of Picric Acid, Santonine, Aloeine, and Cantharidine

The chloroformic and other extracts yielded crystals, which could not be identified, with the exception of Narcotine.

This experiment was really too severe a test. It is unnecessary to state that no such admixture would occur in practice.

The Orchidaceæ of the Bath Flora, Fertilisation, etc.

By William G. Wheatcroft.

Plates 23, 24, 25.

PROFESSOR BABBINGTON, in his "Flora Bathoniensis," published in 1834, and the supplement thereto, published some years later, describes 19 species of British Orchids as growing within the Bath district. These are :—*Orchis morio*, *O. mascula*, *O. ustulata*, *O. pyramidalis*, *O. latifolia*, *O. maculata*, *Gymnadenia conopsea*, *Herminium monorchis*, *Habenaria viridis*,

Habenaria chlorantha, *Ophrys apifera*, *Op. muscifera*, *Op. aranifera*, *Neottia spiralis*, *Listera ovata*, *Listera nidus-avis*, *Epipactis latifolia*, *E. palustris*, and *Cephalanthera grandiflora*, referred to in the "Bath Flora" as *Epipactis grandiflora.* According to that careful and skilled botanist, the Rev. Leonard Jenyns, the Spider Orchis (*Ophrys aranifera*) has either become extinct or its insertion in the Bath Flora was a mistake. The habitat given is on Dry Hills, above Winsley. It is not to be found there now. I have found *Habenaria bifolia* (the Lesser Butterfly Orchis) in a wood between Midford and Limpley Stoke, and the Rev. Canon Ellacombe has found the same species at another station within the Bath district. Bath can, therefore, still boast of the possession of 19 members of this most interesting family of plants. I can vouch for 18. The only species I have not found is *Herminium monorchis.*

Probably the most interesting feature of the Orchidaceous plants is their method of fertilisation. It is to this subject chiefly that I direct attention. It may be stated generally that there are properly in the Orchids three united pistils, or female organs. The upper part of the pistil has its anterior surface soft and viscid, which forms the stigma. The two lower stigmas are often completely confluent, so as to appear as one. The stigma in the act of fertilisation is penetrated by long tubes emitted by the pollen grains, which carry the contents of the grains down to the ovules, or young seeds, in the ovarium. Of the three pistils, which ought to be present, the stigma of the upper one has been modified into an extraordinary organ called the *Rostellum*, which in many Orchids presents no resemblance to a true stigma. The rostellum either includes or is formed of viscid matter ; and in very many Orchids the pollen-masses are firmly attached to a portion of its exterior membrane, which is removed, together with the pollen-masses, by insects. This removable portion consists in most British Orchids of a small piece of membrane, with a layer or ball of viscid matter underneath, which I shall call the "*viscid disc;*" but in many exotic Orchids the portion removed is so large and important that one part must be called, as before, the viscid disc, and the other part the pedicel of the rostellum, to the end of which pedicel the pollen-masses are attached. The grains of pollen are united

by means of short threads of very elastic tissue into small masses, and these into larger, and at length into pellets, having stalks of the same elastic tissue, by which they are all attached to a firmer central stalk, or caudicle. To the lower end of this caudicle (directly to the end of it in our *Habenaria* and Orchids generally) is attached a button-shaped disc, the face of which is exposed, and is on a line with the surface of the anther : so that these two discs look toward each other across the broad stigmatic space (Pl. XXIII., Fig. 1). The exposed face of the disc being covered with a durable layer of very viscid matter, the body itself is sometimes termed a gland. The viscidity is nearly of the same nature as that of the intervening stigma, of which the glands are generally supposed to be detached portions. If so, then a portion of the stigma is cut off from the rest and specialised for the purpose of the conveyance of the pollen. When a finger's end or any small body is applied to these discs they adhere so firmly that the attached pollinia or pollen-masses are dragged out of the cell and carried away entire.

Some of the pollen-masses have been found attached by the disc to the eye of a large moth. When a moth of the size of head and length of proboscis of *Sphinx drupiferarum* visits a spike of these flowers, and presses its head into the centre of the flower, so that its proboscis may reach and drain the nectariferous tube, a pollen-mass will usually be affixed to each eye. On withdrawal these will stand as in the accompanying illustration (Pl. XXIII., Fig. 3). Within a minute, or according to that eminent naturalist, the late Charles Darwin, in 30 seconds, they will be turned downwards (as in Fig. 4), not by their weight, but by a contraction in drying of one side of the thick piece which connects the disc with the stalk. When a moth in this condition passes from the last open flower of one spike to that of another plant, and thrusts its proboscis down a nectary, the transported pollen-masses will be brought in contact with the large glutinous stigma ; on withdrawal, either some of the small pellets of pollen will be left adherent to the stigma, the connecting elastic threads giving way, or else a whole pollen-mass will be so left, its adhesion to the glutinous stigma being greater than that of the disc on the moth's eye. The former is a common and economical proceeding, as then a succession of

flowers are abundantly fertilised by one or two pollen-masses. In either case new pollen-masses are carried off from fresh flowers and applied to the fertilisation of other blossoms on the same, and eventually on those of different individuals. Cases like this and many others show how "sedulous, sure, and economical are the processes of Nature for the intercrossing of hermaphrodite flowers." The accompanying illustration (Pl. XXIV., Fig. 10) will serve to show both what a large supply of pollen-grains each pollen-mass contains, and how slender the elastic threads which connect these pollen-packets are. Pl. XXIII., Fig. 1, is a sketch of a section of *Habenaria chlorantha* (Greater Butterfly Orchis), highly magnified, showing the anthers, stigma, nectary, and labellum. Fig. 2 represents a pollinium of the same Orchis, greatly enlarged, so as to show pollen-masses, caudicle, and viscid disc.

This is a concise general description of the mode of fertilisation of our British Orchids. It would occupy a much larger space than I have at my disposal to give a detailed account of the exact mode in which each species of this rather numerous family is fertilised. I will, therefore, give a description of two or three species only for the purpose of pointing out the different modifications of the reproductive organs and the *modus operandi*. I need scarcely say that to those who take more than a casual interest in the subject, the study of the late Charles Darwin's admirable work on the fertilisation of Orchids will afford a rich treat. I am largely indebted to this unrivalled treatise for the descriptions I have given in this paper. They may therefore be relied upon as being accurate as far as they go. I have selected *Orchis mascula* and *Orchis morio* for the purpose of illustrating the manner in which the members of the Orchis family are fertilised. *O. pyramidalis*, according to Mr. C. Darwin, is the most perfectly constructed British Orchis.

From what has been already stated, it will be noticed that the column of an Orchis is a body formed of a stamen, a style, and a stigma, all grown into one solid body, and this is the great peculiarity of the Orchis tribe. Its genera vary amazingly in the structure of the anther, the column, the lip, and, indeed, of all the parts, but in the consolidation of the style and stamen they

are all agreed. This, then, is the characteristic of the Orchis tribe. I will now proceed to give a detailed description of the construction and manner of fertilisation of *Orchis mascula*, *Ophrys muscifera*, and *Ophrys apifera*. Space will not permit me to attempt more than this.

First, let us take *Orchis mascula* (Early Purple Orchis). The accompanying sketches (Pl. XXIV., Figs. 6, 8, and 9) show the relative position of the more important organs in this flower. The sepals and petals have been removed, excepting the labellum, with its nectary. The nectary is shown only in the side view (Fig. 6); its enlarged orifice is almost hidden in shade in the front view. The stigma is bilobed, and consists of two almost confluent stigmas; it lies under the pouch-formed rostellum. The anther *a* (Figs. 6 and 9) consists of two rather widely separated cells, which are longitudinally open in front; each cell includes a pollen-mass or pollinium. A pollinium removed out of one of the two anther-cells is represented by Fig. 7. It consists of a number of wedge-shaped packets of pollen-grains, united together by excessively elastic thin threads. These threads become confluent at the lower end of each pollen-mass, and compose the straight elastic caudicle. The end of the caudicle is firmly attached to the viscid disc, *d*, which consists of a minute oval piece of membrane, with a ball of viscid matter at its under side. Each pollinium has its separate disc, and the two balls of viscid matter lie enclosed together within the rostellum (Pl. XXIV., Fig. 8). The rostellum is a nearly spherical, somewhat pointed projection (Figs. 6, 8, and 9), overhanging the two almost confluent stigmas, and must be fully described, as every detail of its structure is of great signification. A front view of both viscid discs within the rostellum is given at *d*, *d*, Fig. 8. This latter figure (8) probably best serves to explain the structure of the rostellum; but it must be understood that the front lip is here considerably depressed. The lowest point of the anther is united to the back of the rostellum, as may be seen in Fig. 9. At an early period of growth the rostellum consists of a mass of polygonal cells, full of brownish matter, which cells soon resolve themselves into two balls of an extremely viscid semi-fluid substance, void of structure. These viscid masses are slightly elongated, rather flat on the top, and convex

below. They lie quite free within the rostellum, being surrounded by fluid, except at the back, where each viscid ball firmly adheres to a small portion or disc of the exterior membrane of the rostellum. The ends of the two caudicles are strongly attached to these two little discs of membrane. The membrane forming the whole interior surface of the rostellum is at first continuous; but as soon as the flower opens the slightest touch causes it to open transversely in a sinuous line in front of the anther-cells and of the little crest or fold of membrane between them (see Fig. 8). This act of rupturing makes no difference in the shape of the rostellum, but converts the front part into a lip, which can easily be depressed. This lip is represented considerably depressed in Fig. 8, and its edge is seen in Fig. 9 in the front view. When the lip is thoroughly depressed, the two balls of viscid matter are exposed. Owing to the elasticity of the hinder part, or hinge, the lip, or pouch, when not pressed down, springs up and encloses the two viscid balls. "I will not affirm" (writes Darwin) "that the rupturing of the exterior membrane of the rostellum never takes place spontaneously, and no doubt the membrane is prepared for the rupture by having become very weak along defined lines; but several times I saw the act ensue from an excessively slight touch—so slight that I conclude that the action is not simply mechanical, but for want of a better term may be called vital. . . . At the same time that the rostellum becomes transversely ruptured in front, it probably (for it was impossible to ascertain this fact from the position of the parts) requires behind it two oval lines, thus separating and freeing from the rest of the exterior surface of the rostellum the two little discs of membrane, to which internally the two viscid balls of matter adhere. The line of rupture is thus very complex, but strictly defined. As the two anther cells open longitudinally from top to bottom, even before the flower expands, as soon as the rostellum is properly ruptured from the effects of a slight touch, its lips can be easily depressed, and, the two little discs of membrane being already separate, the two pollinia now lie absolutely free, but are still embedded in their proper places. So that the packets of pollen and the caudicles lie in the anther-cells; the discs still form part of the posterior surface of the rostellum, but are

separate, and the balls of viscid matter still lie concealed within the rostellum."

Now let us see how this complex mechanism acts. Let us suppose an insect to alight on the labellum, which forms a good landing-place, and to push its head into the chamber (see side view Fig. 6, or front view Fig. 9), at the back of which lies the stigma *(s)*, in order to reach with its proboscis the end of the nectary; or, which does equally well to show the action, push a sharply-pointed common pencil into the nectary. Owing to the pouch-formed rostellum projecting into the gangway of the nectary, it is scarcely possible that any object can be pushed into it without the rostellum being touched. The exterior membrane of the rostellum then ruptures in the proper lines, and the lip or pouch is most easily depressed. When this is effected, one or both of the viscid balls will almost infallibly touch the intruding body. So viscid are these balls that whatever they touch they firmly stick to. Moreover, the viscid matter has the peculiar chemical quality of setting, like a cement, hard and dry, in a few minutes' time. As the anther-cells are open in front, when the insect withdraws its head, or when the pencil is withdrawn, one pollinium, or both, will be withdrawn, firmly cemented to the object, projecting up like horns, as shown (Figs. 3 and 5). The firmness of the attachment of the cement is very necessary, as we shall immediately see; for if the pollinia were to fall sideways or backwards they could never fertilise the flower. From the position in which the two pollinia lie in their cells they diverge a little when attached to any object. Now let us suppose our insect to fly to another flower, or insert the pencil with the attached pollinium into the same or another nectary. By looking at the diagram (Fig. 3) it will be evident that the firmly attached pollinium will be simply pushed against or into its old position, namely, into its anther-cell. How, then (continues Mr. Darwin). can the flower be fertilised? This is effected by a beautiful contrivance. Though the viscid surface remains immovably affixed, the apparently insignificant minute disc of membrane to which the caudicle adheres is endowed with a remarkable power of contraction, which causes the pollinium to sweep through about 90 degrees, always in one direction—viz., towards the apex of the

proboscis, or pencil, in the course, on an average, of 30 seconds. The position of the pollinium after the movement is shown at Figs. 4 and 5. Now after this movement and interval of time (which would allow the insect to fly to another flower), it will be seen by turning to the diagrams (Figs. 4 and 5) that if the pencil be inserted into the nectary, the thick end of the pollinium will exactly strike the stigmatic surface.

Here again comes into play another pretty adaptation, long ago noticed by Robert Brown. The stigma is very viscid, but not so viscid as, when touched, to pull the whole pollinium off the insect's head or off the pencil, yet sufficiently viscid to break the elastic threads (Figs. 1 and 2), by which the packets of pollen-grain are tied together and leave some of them on the stigma. Hence a pollinium attached to an insect can be applied to many stigmas and will fertilise all. Mr. Darwin relates that he has seen the pollinia of *Orchis pyramidalis* adhering to the proboscis of a moth, the stump-like caudicle alone remaining, all the packets of pollen having been left glued to the stigmas of the flowers successively visited. This description of the action of the organs in *O. mascula* applies to *O. morio* and *O. maculata*. These three species present slight differences in the length of the caudicle, in the direction of the nectary, and in the shape and position of the stigma, but they are not worth detailing. The pollinia in *O. morio* undergo after removal from the anther-cells the same peculiar movement of depression as in *O. mascula*.

Ophrys muscifera, the Fly Ophrys.—The *Ophreæ* differ from *Orchis* mainly in having two separate pouch-formed rostellums, instead of the two being confluent as in *Orchis*. This, as Mr. Darwin observes, is not a strictly accurate description, but it may be forgiven on account of its convenience. In the Fly Ophrys (*O. muscifera*) the chief peculiarity is that the caudicle of the pollinium (*c*, Fig. 13) is doubly and almost rectangularly bent. The nearly circular piece of membrane, to the under side of which the ball of viscid matter is attached, is of considerable size, and plainly forms the summit of the rostellum, instead of forming, as in *Orchis*, the posterior and upper surface; consequently the attached end of the caudicle, after the flower has expanded, is exposed to the air. As might have been expected

from this circumstance, the caudicle is not capable of that movement of depression characteristic of all the species of *Orchis*, for this movement is always excited when the upper membrane of the disc is first exposed to the air. The ball of viscid matter is bathed in fluid within the pouch formed by the lower half of the rostellum, and this is necessary, as the viscid matter rapidly sets hard in the air. The pouch is not elastic, and does not spring up when the pollinium is removed. Such elasticity would have been of no use, as there is here a separate pouch for each viscid disc, whereas in *Orchis*, after one pollinium has been removed, the other has to be kept covered up and ready for action. Hence it would appear as if Nature was so economical as to save even superfluous elasticity. The pollinia, as Mr. Darwin observes, cannot be jarred out of the anther-cells by violence. This eminent naturalist remarks, "That insects of some kind visit these flowers, though not frequently, and remove the pollinia, is certain. Twice I have found abundant pollen on the stigmas of flowers, in which both their own pollinia were still in their cells, and no doubt had I looked oftener I should have oftener observed this fact." My own observation agrees with this.

Mr. Darwin continues:—"The elongated labellum forms a good standing-place for insects; at its base, just beneath the stigma, there is a rather deep depression, representing the nectary in *Orchis*, but I could never see a trace of nectary, nor have I observed any insects, often as I have watched these inconspicuous and scentless flowers, even approach them. On each side of the base of the labellum there is a shining knob, with an almost metallic lustre, appearing like two drops of fluid; and if I could in any case believe in Sprengel's sham nectaries, I should believe it in this instance. What induces these insects to visit these flowers I can at present only conjecture. The two pointed pouches covering the viscid discs stand not far apart, and project over the stigma; any object pushed gently right against one of them (in *Orchis* the push should be directed rather downwards) depresses the pouch, touches and adheres to the viscid ball, and the pollinium is easily removed. The structure of the flower leads me to believe that small insects crawl along the labellum to its base, and that in bending their heads downwards or upwards they strike

against one of the pouches ; they then fly to another flower with a pollinium attached to their heads, and there, bending down to the base of the labellum, the pollinium, owing to its doubly-bent caudicle, strikes the sticky stigmatic surface, and then leaves the pollen on it."

That insects do visit the flowers of the Fly Ophrys and remove the pollinia, though not effectually or sufficiently, is abundantly proved. A German botanist has suggested that the appearance of the flower alarms insects ; as to whether this is so or not I do not venture to give an opinion. One thing is certain —that very few of the flowers get fertilised ; hence the comparative rarity of the species. Mr. Darwin writes : "The year 1861 was extraordinarily favourable to this species in this part of Kent, and I never saw such numbers in flower ; accordingly, I marked eleven plants, which bore forty-nine flowers, but these produced only seven capsules. Two of the plants each bore two capsules, and three other plants each bore one, so that no less than six plants did not produce a single capsule ! What are we to conclude," asks the great naturalist, "from these facts ? Are the conditions of life unfavourable to this species, though it was so numerous in some places this year as to deserve being called quite common ? Could the plant nourish more seed ; and would it be of any advantage to it to produce more seed ? Why does it produce so many flowers if a larger number of seeds would not be advantageous to it ? Something seems to be out of joint in the machinery of its life. We shall presently see what a remarkable contrast another species of this same genus, *Ophrys apifera*, or the Bee Ophrys, presents in producing seed."

I will next direct your attention to this very interesting member of the Ophrys family, the Bee Ophrys which grows so abundantly in this district. I cannot do better than quote *verbatim* from Mr. Darwin. He observes :—"In the Bee Ophrys we meet with widely different means of fertilisation as compared with the other species of the genus, and, indeed, as far as I know, with all other Orchids. The two pouch-formed rostellums, the viscid discs, and the position of the stigma, are nearly the same as in other species of Ophrys ; but, to my surprise, I have observed that the distance of the two pouches from each

other and the shape of the mass of pollen-grains are variable. The caudicles of the pollinia are remarkably long, thin, and flexible, instead of being, as in the other *Ophryeæ*, rigid enough to stand upright. They are necessarily curved forward at their upper ends, owing to the shape of the anther-cells, and the pear-shaped masses of pollen lie embedded high above and directly over the stigma. The anther-cells naturally open soon after the flower is fully expanded, and the thick ends of the pollinia fall out, the viscid discs still remaining in their pouches. Slight as is the weight of the pollen, yet the caudicle is so thin, and soon becomes so flexible, that, in the course of a few hours, they sink down until they hang freely in the air (see lower pollen mass in Fig. 11, *p p*), exactly opposite to, and in front of, the stigmatic surface. When in this position a breath of air, acting on the expanded petals, sets the flexible and elastic caudicles vibrating, and they almost immediately strike the viscid stigma, and, being thus secured, impregnation is effected. To make sure that no other aid was requisite, though the experiment was superfluous, I covered up a plant under a net, so that some wind but no insects could pass in, and in a few days the pollinia had become attached to the stigmas ; but the pollinia of a spike kept in water in a still room remained free, suspended in front of the stigma. Robert Brown* first observed that the structure of the Bee Ophrys is adapted for self-fertilisation. When we consider the unusual and perfectly-adapted length, as well as the remarkable thinness, of the caudicles of the pollinia : when we see that the anther-cells naturally open, and that the masses of pollen from their weight slowly fall down to the level of the stigmatic surface, and are there made to vibrate to and fro by the slightest breath of wind till the stigma is struck : it is impossible to doubt that these points of structure and function, which occur in no other British Orchid, are specially adapted for self-fertilisation. The result is what might have been anticipated.

"I have often noticed that the spikes of the Bee Ophrys apparently produced as many capsules as flowers. Near Torquay I carefully examined many dozen plants, some time after the flowering season, and on all I found from one to four and occasionally five capsules,

* Trans. Lin. Society, Vol. XVI., p. 740.

i.e., as many capsules as there had been flowers. In extremely few cases (excepting a few deformed flowers, generally on the summit of the spike) could a flower be found which had not produced a capsule. . . . From what I have seen of the British Orchids, I was so much surprised at the self-fertilisation of the species that during many years I have looked at the state of the pollen-masses in hundreds of flowers, and I have never seen in a single instance reason to believe that pollen had been brought from one flower to another. Excepting in a few monstrous flowers, I have never seen an instance of the pollinia failing to reach its own stigmas. In a very few cases I have found one pollinia had vanished, but in some of these cases the marks of slime led me to suppose that slugs had devoured them."

The winged carriers which perform the office of conveying pollen are doubtless mainly moths and butterflies. Mr. Darwin states that he has never seen any other insect visit Orchids, though he had watched them for twenty years. The sweet scent of *Habenaria chlorantha*, and *Gymnadenia conopsea* is calculated to attract insects. As the former does not give out its sweet scent until sunset, it probably attracts the *night-flying* moths. That bees occasionally visit some of the species of Orchids cannot be doubted. The very interesting specimen of a humble bee with five pollinia attached to it, which I have seen in the possession of a friend, is the best evidence that can be adduced. M. Maniér speaks of having seen, in Dr. Guépin's collection, bees collected at Saumur with the pollinia of Orchids attached to their heads, and Professor Westwood sent Mr. Darwin a humble bee and hive bee, both with pollinia attached to them. Mr. F. Bond also sent to him a large number of moths in this condition. Mr. Darwin gives a list of some 23 species of Lepidoptera with the pollinia of *O. pyramidalis* attached to the proboscis. One unfortunate *Caradrina* had no less than eleven pairs attached to its proboscis. Thus encumbered, it could not possibly reach the extremity of the nectaries, and must soon have come to an untimely end.

I have to thank my wife for the sketches made from nature of the various Orchids referred to, and for having reduced the same for the purpose of the plates which accompany this paper.

EXPLANATION OF PLATES XXIII., XXIV., XXV.

Plate XXIII.

Fig. 1.—Section of *Habenaria chlorantha*. *a*, *a*, anther; *d*, *d*, viscid disc; *s*, stigma; *n*, nectary; *n'*, orifice of nectary; *l*, labellum.

,, 2.—Pollinium viewed laterally. *p*, pollen-masses; *c*, caudicle; *d*, viscid disc.

,, 3.—Head of Moth, with two pollinia affixed to the eyes.

,, 4.—Ditto, one minute after extraction.

,, 5.—Pencil with two pollinia, one upright (just extracted), the other as it appears one minute after extraction.

Plate XXIV.

,, 6.—Section of *Orchis mascula*. *a*, anther; *r*, rostellum; *s*, stigma; *l*, labellum; *n*, nectary.

,, 7.—Pollinium of same, showing, *p*, pollen-masses; *c*, caudicle; *d*, viscid disc.

,, 8.—Front view of discs, *d*; and caudicles, *c*; both pollinia being within the rostellum, *r*.

,, 9.—Front view of section of *O. mascula*. *a*, anther; *r*, rostellum; *s*, stigma; *l*, labellum; *n*, nectary.

,, 10.—Packet of pollen of *Habenaria* attached by minute threads, highly magnified.

Plate XXV.

,, 11.—*Ophrys apifera*. *p*, *p*, pollinia; *l*, labellum.

,, 12.—Front view of *Ophrys muscifera*. *a*, anther; *r*, *r*, rostellum; *s*, stigma; *l*, labellum.

,, 13.—Pollinium of *Ophrys muscifera*. *p*, pollen-masses; *c*, caudicle; *d*, viscid disc.

Drawn by Mrs. Wheatcroft.

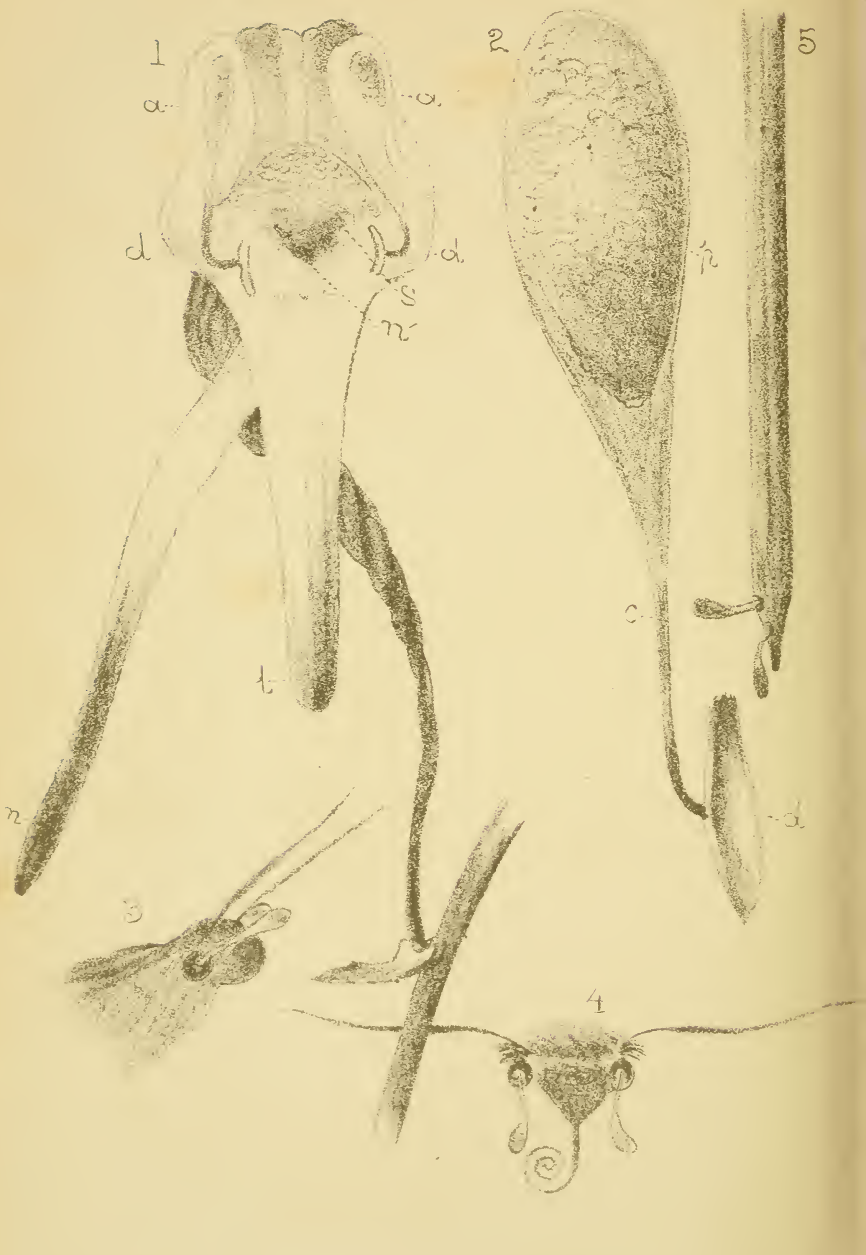
The Microscope and How to Use it.

By V. A. Latham, F.M.S.

Part VIII.

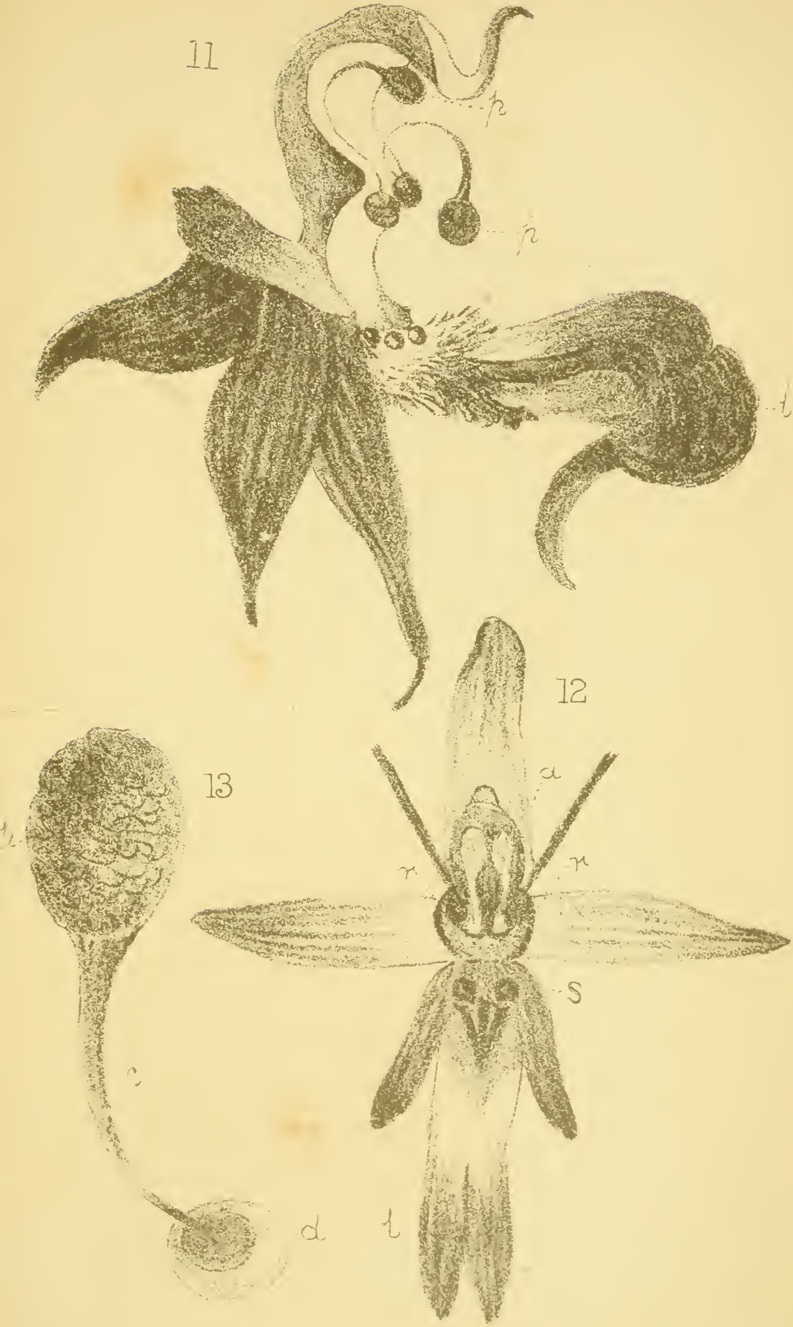
B.—Agents which Harden and at the same time Colour the Tissues.

Osmic Acid.—One per cent. solution in water, which can be diluted at pleasure. The solution must be kept in a well-stoppered and dark-coloured glass bottle. It stains fat globules black, and



Fertilisation of Orchids.

Fertilisation of Orchids



Fertilisation of Orchids

brings out the medullary sheath of nerves. Specimens must remain in it for from a quarter of an hour to several hours. In hardening tissues, always insert in your note-book the name of animal, tissue, date of injecting, of changing or substituting fluids, and any facts of special interest; or, if the student prefers, or will give a little extra time, I should recommend him to copy his description also on to the label of the bottle in which the tissue is put, but not to rely on the label only, as it may become unfastened or get defaced. The following is a rough copy of the way in which I insert notes in my little book, and if I afterwards feel inclined I can add to them, and so make the directions, etc., quite complete :—

Osmic Acid, ($Os\ O_4$).

Of great service for embryonic tissues, nerve-fibres, retina, connective tissue, corpuscles, epithelium, epidermis, testis, etc.

It *quickly* colours fat-cells and medullary nerve-matter.

It *more slowly* colours ganglion cells, axis cylinders, muscles, and cells rich in protoplasm, and the internal ear.

It *most slowly* colours connective tissue.

Very small pieces may be immersed in a from 1 per cent. to 2 per cent. solution for from a quarter of an hour to twenty-four hours, and these solutions also harden, but 1—10 per cent. solution which does not harden may also be used. After hardening, first wash in distilled water, then place in rectified spirit. Secondly, sections are made, and mounted in a saturated solution of acetate of potash or in Farrant's fluid. The former is the best, for glycerine renders them too transparent.

N.B.—Avoid Osmic Exhalations.

The last line stands out distinct and clear, so that no mistake *can* be made. The vapour is dangerously irritating to the conjunctiva and nostrils, and is also excessively poisonous; great care must therefore be taken.

Picric Acid.—A cold, saturated aqueous solution; keep more crystals in the bottle to ensure saturation. Small pieces of the material to be hardened are put in a large quantity of the fluid, and ought only to be left in it for a day or two, or they will be rendered too brittle. Its stain is of a bright yellow colour, which

is easily removed by prolonged washing in water (Ranvier). Tissues easily stain in picro-carmine. Sometimes one part of water is added to two parts of the saturated solution. It is used to decalcify the bones, and for the salivary glands and pancreas.

Kleinenberg's Picric Acid is a modification of the above. To 100 cc. of a cold, saturated, aqueous solution of picric acid add 2 cc. of strong sulphuric acid, which throws down a yellow precipitate. Filter, and to the filtrate add 300 cc. of distilled water. This solution is most valuable for fœtal tissues, and especially for early embryos. It produces its effects in from three to ten hours.

Silver Nitrate is useful in all cases when it is required to demonstrate the flat tesselated or endothelial cells of serous membranes. This salt is taken up by the intercellular substance when fresh, and reduced as a black precipitate under the action of light, and so maps out the cells in black lines. The tissue must be *perfectly fresh*, and placed directly after removal from the body in a ·5 per cent. or ·25 per cent. solution for from ten to fifteen minutes; then washed carefully in distilled water, and exposed to the light in glycerine diluted with three times its bulk of distilled water. Silver is also used to stain nerve-fibres. To prepare the solution:—Finely powder in a mortar 5 grammes (1 drachm 17 grains) of crystallised nitrate of silver; add gradually 1,000 cc. (35 ounces 2 drachms 20 minims) of cold distilled water. When the salt has dissolved, preserve in a dark-stoppered bottle and keep in a dark cupboard. The use of silver nitrate in bringing in view the cell-spaces of the cornea will be alluded to later on. Sections may be mounted in Canada Balsam.

Ammonium-molybdate produces a bluish-grey general stain, which acts well as a base for double staining; a 5 per cent. solution in water may be used, and the specimens should be exposed to the light for twenty-four hours. The salt is expensive, and the advantages of its use not very marked.

Palladium chloride, in solutions varying from 1 per cent. to 5 per cent., is occasionally used. We simply mention it as it has the same effect as gold chloride in hardening and staining tissues. It is very expensive, and, unfortunately, with many tissues, as

brain and epidermis, its action is quite superficial. Objects on which this has been used should be carefully washed and mounted in glycerine.

Gold Chloride selects and stains certain tissues, principally nervous; it also brings out the cells of fibrous connective tissue, cartilage, and cornea. Remove the tissue, and place it immediately in 5 per cent. solution of gold chloride for half-an-hour to an hour; it should then be removed to distilled water for about twelve hours, and afterwards exposed to light in a saturated solution of tartaric acid until it sinks. Formic acid may be used in place of tartaric acid.

Method of preparing Gold Solution.—The gold is sold in small glass tubes, each containing 15 grains of chloride, equal to 7 grains of pure gold. Take one of these tubes and file a ring round it, above the bulb; it can then be easily divided into two parts. Empty the gold chloride into a six-ounce bottle, and wash out any particles that remain with distilled water, and fill up the bottle. This will make less than ½ per cent. solution, but answers very well, and should be preserved in a dark bottle similar to nitrate of silver. Mount the preparation, if it is thin like a rat's tail, in glycerine. (For further particulars see "Staining with Gold Chloride," *Journal of Microscopy*, Vol. IV., p. 244.)

Lime-water.—After maceration for six or eight days, connective tissue and tendons may be separated into fibrillæ by needles.

Baryta-water acts similarly to the above, in from four to six hours. The swelling is greater, and the transparency more considerable. In both cases before the application the tissue is to be washed with distilled water, or, what is better, distilled water with a drop of acetic acid.

Drying Process is especially useful for skin, tendons, walls of vessels, lungs (even injected), muscles, epidermis, crystalline lens, umbilical cord, intestine; the latter we have injected and then dried with great success. The dried pieces can be kept in a box, with the addition of a piece of camphor, and constitute excellent material for many histological demonstrations. Dry on a board or a piece of cork; to avoid wrinkling they may be stretched and

fastened with pins. A temperature of 30° or 40° C. is most suitable. The thin sections which are made are to be softened in pure water, or water with a little acetic acid. If they are to be stained, they may be placed directly in the carmine, etc.

Boiling in vinegar is useful in some cases; the crystalline lens is obtained by this method.

A good way to harden tissues is to cut the organ into a number of small pieces, and to suspend them, by means of a thin cord, in a large globe or vessel. Attach the cord to a cork, which must have a number or letter on it corresponding with the same in your pocket-book, with the name, etc.; the fluid is changed as usual and spirit added. The advantages are that various organs can be put together in one lot of spirit or acid, and a far greater number hardened at once. Care must be taken that *too* many pieces are *not* put in the vessel at one time.

Normal Fluids.

Fluids which do not alter the appearance of fresh tissues are thus called. Under certain conditions it is advisable to examine the tissues in a fresh condition. These fluids resemble in composition those in which the tissues of the body are bathed.

1.—Aqueous Humour of the Eye.—This is easily obtained by puncturing the cornea of an eye-ball removed from an ox newly killed.

2.—Blood Serum.—Pour blood into a tall vessel and allow it to coagulate. After the blood coagulates, run a knife between the upper margin of the clot and the vessel, to permit the clot to contract and sink in the serum, which will be squeezed out of the clot. After twenty-four hours draw off the yellow-coloured serum with a pipette.

3.—Iodised Serum.—Add iodine to blood-serum, prepared as above, until the fluid is of a distinctly yellow colour. This fluid alters the tissues slightly, however, and colours them yellow. A similar solution may be made by adding iodine to amniotic fluid.

Another method is to add 1 cc. tincture of iodine and 1 or 2 drops of carbolic acid to 100 cc. fresh amniotic fluid, pericardial

fluid, iodised serum, or dilute albumen—any of these may be used—and filter.

4.—Salt Solution.—Dissolve 7·5 grammes sodic chloride (common salt) in 1,000 cc. of distilled water. This is by far the most convenient fluid to employ. Its composition is so near that of lymph—the fluid normally bathing the tissues—that it alters fresh tissues very slightly.

Decalcifying Solutions.

A good solution for softening bone may be made by mixing chromic acid, 1 gramme; strong nitric acid, 2 cc. : water, 200 cc. When the bone is softened sufficiently to allow a fine needle to be passed through it, it should be removed from the solution and thoroughly washed in water, after which it must be hardened in alcohol. The nitric acid removes the lime salts, whilst the chromic acid hardens the parts. If the fluid is not changed, a few drops of nitric acid may be added from time to time, if the softening process is delayed too long.

Hydrochloric Acid.—One part of strong acid, with 10 parts of water, does well for injected bone.

Picric Acid.—A saturated watery solution should be used; it is of great value for decalcifying fœtal bones. The mixture should be frequently changed, or a few crystals added from time to time.

A 10 per cent. Solution of Common Salt and Hydrochloric Acid.—This is most valuable for showing the matrix of bone, which consists of ordinary fibrous tissue, and swells up in the ordinary acid media. A 10 per cent. solution of salt prevents this (V. Ebner and De B. Birch). The bone is placed in a 10 per cent. solution of common salt, to which 1 to 3 per cent. of hydrochloric acid is added. Add from day to day as much acid as will decalcify the bone; when the bone becomes flexible, it is placed for several hours in water, to remove all the acid. Leave it for several days in the 10 per cent. salt solution, which must be changed repeatedly. When the reaction of the bone becomes neutral, the bone is white and opaque. Sections are made and mounted in a 10 per cent. solu-

tion of salt. They show the fibrillar structure of the matrix (V. Ebner).

Dissociating Solutions.

These solutions dissolve or soften certain parts of a tissue whilst other parts are left unaffected. The result is that the component parts may be readily separated by teasing. The piece of tissue ought not to be larger than a pea. The result is usually effected in from twenty-four to thirty-six hours, though a much shorter time will often suffice.

Nitric Acid and Glycerine.—Mix one part of strong nitric acid containing nitrous acid with three parts of water and one part of glycerine. The object is placed in this mixture for two or three days, and then removed to water. It is specially useful for isolating nerve-structures and lens-fibres (Freud). Osmic acid—·1 per cent. to 1 per cent., Müller's fluid—is used for stomach and kidney.

Hydrochloric and Sulphuric Acids.—For a fuller description see "Hardening Solutions," p. 184.

Dissociating Fluids.

Iodised Serum.—Add iodine to blood-serum or amniotic fluid if the fluid is of a distinctly yellow colour. This fluid dissolves the cement-substance between cells in from one to two days. I find the following a very good method:—Take white of egg, 1 ounce; water, 9 ounces; common salt, 2 scruples; and add 6 drops of concentrated tincture of iodine to each ounce while shaking the mixture. If the solution becomes pale, a few drops more iodine should be added. This may be also used as a normal fluid.

Dilute Chromic Acid (·01 per cent.).—Dissolve one gramme nitric acid in 10,000 cc. of water, or dilute 1 per cent. solution. This does excellently for isolating the fibrillæ of muscle, and for the nerve-cells of the spinal cord. Two or three days' maceration serves to bring about the result.

Dilute Alcohol ("*Alcool au tiers*").—Mix 2 parts of water and 1 of rectified spirit. This is one of the most useful dissociating fluids, and requires one or two days for its action.

Saturated Aqueous Solution of Baric Hydrate requires about twenty-four hours to act on the fibrillæ of tendon.

Caustic Potash.—Dissolve 40 grammes of potash in 100 cc. of water ; it isolates muscle-cells in from twenty to thirty minutes.

Ten per cent. solution of Common Salt is useful for dissolving the cement of white fibrous tissue. It takes several days to act. It is very useful also for showing the fibrillæ of the matrix of the bone.

Nitric Acid and Glycerine.—Mix 1 part of strong nitric acid containing nitrous acid, with 3 parts of water, and 1 part of glycerine. The object is placed in this mixture for two or three days, and then in water. It is specially useful for isolating nerve-structures and lens-fibres of the eye.

Teasing

Is done with needles, mounted in some kind of handles. Cut a very small piece of the tissue, and place it on a slide in a small drop of the fluid in which it is to be mounted—generally glycerine. Fix one end of the tissue with a strong needle, and tear it with the other needle in the direction parallel with the fibres. Some tissues cannot be so separated, so they must be broken up into minute pieces. Examine from time to time with a lens or a dissecting microscope. If it be a coloured object, a small piece of white bibulous paper should be used for a background; if uncoloured, a dark surface.

Digestion

As a histological method has been recently employed by Kühne for investigating the structure of nerves, and by De Burgh Birch in studying the composition of the matrix of bone. Either artificial, gastric, or pancreatic juice may be employed. Artificial pancreatic, *i.e.*, Trypsin digestion.—Use either an aqueous or glycerine extract of the pancreas. The latter I prefer, which is made as follows* :—The pancreas of a dog is chopped up and dehydrated with absolute alcohol for twenty-four hours. The alcohol is removed, and sufficient pure glycerine is added to cover the

* Von Wittich's method.

gland, and allow to stand for three weeks. Press the glycerine through muslin to remove the gland tissue. The glycerine is a solvent for the *trypsin* of the pancreas, just as it is for other soluble ferments. One cc. of the glycerine filtrate is added to 19 cc. of 1 per cent. solution of sodic carbonate. The fluid becomes turbid, but after filtration a pale yellow fluid is obtained. The tissue to be digested is placed in this fluid, and the whole is kept at a temperature of 40° C. in a water bath. Sections of softened bone digested by this method are preserved in a 10 per cent. solution of common salt (Birch).

Artificial Gastric Digestion for Skin, etc.—This was introduced by Dr. Stirling several years ago, but, as it is little known, I have ventured to insert it here. It is invaluable for ascertaining the arrangement of the elastic fibres and muscular tissues in the *skin.* It depends for its value on the fact that certain substances are digested more rapidly than others, and so are rapidly removed. Make the gastric juice by mixing 1 cc. of pure hydrochloric acid with 500 cc. water, and add 1 gramme of pepsin, or a few drops of a glycerine extract of the gastric mucous membrane. It is well to keep the mixture at 38° C. for two or three hours before using. The piece of skin to be digested is stretched over a small glass ring and firmly tied to it. It is then placed in some (200 cc.) of the digesting fluid, which is kept at a temperature of 38° C. in an ordinary water bath for a period varying from three to eight hours—the time depending on the age and size of the piece of skin. After partial digestion the skin is placed in water for twelve hours, when it swells up and becomes extremely transparent. It may be kept most advantageously in a 10 per cent. solution of common salt, and may be hardened in one of the ordinary hardening fluids, and afterwards stained with logwood and carmine. It is also applicable to other tissues. I would advise readers to try the method, and am sure they will be satisfied with the results.

Half-an-Hour at the Microscope

With Mr. Tuffen West, F.L.S., F.R.M.S., etc.

THE notes selected for the present issue of our Journal were written by Mrs. Tuffen West, but the drawings, we believe, are by Mr. West.

Flint.—The formation of Flint is a most interesting question, in considering which great care must be exercised not to confound together two things essentially distinct, viz.—the *deposition* of siliceous material, grain for grain, in the tissues of living organisms, which is a chemico-vital process; and the *separation* of similar material from its solution by dead or dying organic matter through a purely chemical action. That the tissues of some plants have a selective power cannot be doubted, and indeed it is a very wonderful power when we come to consider it. By what power is it, for instance—unless one impressed upon it *ab initio*—that the Diatom separates silica, and incorporates it so largely with its tissues, whilst the Desmid will have nothing to do with it? There is an old and favourite puzzle with young folks. It is a model ship, fully rigged, or something of the kind, enclosed in a glass bottle, through the neck of which it never *could* have got, by any amount of ingenuity or squeezing. Of course, the bottle, whilst in the soft state, was formed around it. Just so with the Foraminifera referred to by Mr. Nicholson, p. 240. They either were attached to some gelatinous organism, which has perished, or have become enveloped in it; whilst this decomposed, by mutual affinity silica united with it, and the result is a flint. In connection with the remarkable state of preservation in which we find these delicate organisms may be mentioned some experiments by H. J. Slack and W. Roberts on "Colloid silica," reported in the Transactions of the Microscopical Society of London, July, 1868, p. 105. They found what appeared to be fungi in some pure aqueous solution of silica, on which experiments on Dialysis were being made. This set them thinking, and by enclosing mouldy cheese and other similar organic substances in the solution of silica, they succeeded in obtaining fungi artificially fossilised, some of which bore a remarkable resemblance to Moss Agates. It is curious to note that such delicate structures as these fungoid and beaded threads are not torn or materially compressed in the process of solidification of the colloid silica. In Mr. Roberts' specimens, in which the solidification took place very slowly, the fungoid plants look in as natural a condition as when they were floating freely in the limpid solution. The remarkable Foramini-

fera found by Mr. Nicholson, and figured on Pl. XXVI., Fig. 4, belongs to the genus *Lingulina*, and does not differ in any appreciable respect from *L. carinata*, although, as some unnamed British fossil species have been found in the Gravesend chalk, we must suppose that some naturalists would separate it under a different specific name.

Tongue of Loligo (Pl. XXVI., Fig. 3).—In the Boulogne aquarium we had the advantage of watching a number of Squids in the living state, and were much struck with the ease, rapidity, and elegance of their movements. They swim horizontally, like fish, and in general build resemble a hippopotamus without limbs. The tentacles are usually held close together in front of the mouth, occasionally unrolling a little so as to show the suckers; the eye has a similar resemblance to that of the Dog-fish—watchful and wary, yet with something about it that gave the idea of being cruelly cold and repellent.

Head of Empis (Pl. XXVI., Figs. 1 and 2).—Viewed in connection with their mode of life, few things are more interesting than the mouths of insects. The *Empidæ* feed upon living flies, and may frequently be seen on the wing sucking the juices of their prey. The powerful mandibles, armed with stout spikes for holding; the lancet-like maxillæ for making the first incisions; the tongue acting like the chopper of a sausage-machine; and the curious pump of the under lip—all these here forcibly arrest the attention.

Larva of Gnat.—Two species of larvæ may frequently be found in our water-butts, one of which has the mandibles formed of a series of combs, whilst in the other they are mere brushes formed of plain setæ.

Sept., 1878. E. M. West.

Selected Notes from the Society's Note-Books.

Foraminifera from Hollow Flint (Pl. XXVI., Fig. 4).—This was found in the chalky matter of a hollow flint where water could not enter. How, then, did the Foraminifera become silicified, thus excluded from light, heat, and moisture, and widely differing in appearance from the common flint? It polarises beautifully with a 2 or 3 in. object-glass and selenite. I wish to direct attention to a connected series of cells unlike any I have before met with (see Sketch).

A. Nicholson.

Flint.—The formation of Flint nodules is a puzzle which has frequently occupied my thoughts without satisfactory conclusion. I am inclined to favour the chemical theory, with the silica playing the part of an acid and existing thus in combination in the ocean —say, as silicate of lime or other salt, resting upon the chalk bottom. Imagine that for some reason a fresh body comes into play. The lime leaves the flint for this new body, for which it has a greater affinity, and the silica is set free in a fluid condition; that it sinks to the bottom of the ocean, enveloping in the way sponge and such-like organisms as it may meet, more or less insinuating itself among the chalk, thus acquiring its often grotesque forms, and, gradually hardening, receiving at the same time during the process a coating of silicate of lime, such as we see on our flint nodules, be they large or small. We must think of all this done on the grand scale upon which Nature works, and that after this the formation of chalk was continued. No doubt, the chalk was in a semi-fluid condition.

Flint must be one of the most extensively diffused bodies in nature. No doubt, water dissolves some portion, but it must be in almost all soils in different combinations. The delicate root-fibres of plants which require the presence of flint must exercise their wondrous powers of selection, and carry up the flint in solution to deposit it on the surface to give strength to the plant, as in the wheat and others, to enable the otherwise weak stem to support a heavy head of corn. The canes of tropical countries consist to a large extent of this material, not only in their highly-polished exterior, but also in the interior structure, where it presents longitudinal formations more resembling the familiar spicules of sponge.

It is easy to image more or less fluid silica in its passage to the bottom enveloping small organisms, carrying them with it, hardening them, and presenting them in the state in which we observe them. Nevertheless, many questions, even in theory, are unsolved in regard to flint, and the slide referred to above by Mr. Nicholson is a case in point. I apprehend that when the flint in this case overflowed the chalk, which it enclosed, the chalk was in a more or less moist state, the water containing silica in some form in *solution*. This affords much subject for thought.

W. CASE.

Volvox globator.—Having had the good fortune to meet with a great number of these beautiful objects in a pond near here (Stroud, Gloucestershire), I have been experimenting to ascertain what is the best medium to preserve them in, and have met with

great success with common salt and distilled water. Some weeks ago I mounted some specimens with the above medium in a shallow cell, and they now retain the same shape and colour as when taken from the pond. Of course specimens mounted in this way only do for low powers. A good description of Volvox appeared in the *Popular Science Review*, July, 1878.

WM. ELLIOTT.

Sphagnum—Bog Moss.—The Sphagnums may be found in nearly every boggy place. They have a whitey-brown appearance, sometimes tinged with red or green, and are described in books as "mosses without roots." The Sphagnums have little bladders (utricles) attached to their stalks to buoy up the plants when in the water; these utricles also have certain distinctive characteristics in different species. The specific names usually refer to the form of the leaf.

Some authors divide the order into obtuse-leaved and acute-leaved. *S. molluscum*, *S. cymbifolium*, and *S. compactum* may be classed in the obtuse-leaved division. *S. squarrosum*, *S. acutifolium*, and *S. plumosum* may be placed in the acute-leaved division.

S. cymbifolium is a very common moss, easily remembered by its spoon or boat-shaped leaves, and its large size (6 to 12 inches). The utricles of stem have spiral fibres.

S. compactum has leaves similar to the above, but a more densely tufted habit and smaller size (2 to 4 inches). The utricles of stem have the same external form as *S. cymbifolium*, but without any spiral fibres.

S. molluscum is a tiny species (2 to 4 inches) with obtuse leaves, and has utricles with the upper lips hooked and free, also without spiral fibres.

S. acutifolium is a common species, and has narrow-pointed leaves; the size of the plant varies from 6 to 12 inches long.

S. squarrosum, as its name indicates, has acute squarrose leaves.

S. plumosum has a beautiful feathery appearance, and usually grows floating in the water, but when taken out the leaves collapse like a mop.

W. N. CHEESEMAN.

Apathus.—Kirby and Spence (small edition, p. 353) call these insects parasitic inhabitants of some humble bees' nests, being unprovided with the usual polliniferous organs.

E. E. JARRETT.

Sphagnums.—The division of Sphagnums into acute and obtuse leaved is a thing of the past. They are now divided according to habit and leaf structure, and many of the principal specific differences are obtained from the stem leaves. There is no species now called *compactum*, a more intimate knowledge of the structure and variations of this interesting class of mosses having proved that many of the species have varieties which assume this *compact* form. Thus we have *S. cymbifolium* var. *compactum*, *S. rigidum*, var. *compactum*, etc. etc. It is not safe to attempt to discriminate species by means of a single branch. Dr. Braithwaite, in his monograph of the genus, lays considerable stress on the position and arrangement of the chlorophyll cells, which may be seen with a high power and in a section of the leaf.

CHAS. P. HOBKIRK.

The chlorophyll granules may be distinctly seen with the $\frac{1}{4}$-inch objective.

A. HAMMOND.

Bees.—A member asks for a description of the different sorts of bees. I think he can scarcely be aware that there are upwards of three hundred varieties in Britain alone ; so that, a bee being found, it is by no means easy to make out its specific name. It is, however, tolerably easy to make out the family to which it belongs.

The first thing to be done is to ascertain to which of the two great divisions it belongs : *i.e.*, to the short-tongued or to the long-tongued. In the first division the tongue is shorter than the maxillæ ; in the second the tongue is longer than the maxillæ and folded beneath.

The short-tongued bees are then divided into those having hairs on the posterior tibiæ and those without such hairs.

Bees having polliniferous hairs are divided into such as have two submarginal cells in the upper wings and those having three submarginal cells.

Of those having two submarginal cells there are only two families, viz., (1) *Macropis*, with short and dense polliniferous hairs on the tibiæ and plantæ ; and (2) *Dasypoda*, where the legs are slender, and the hairs dense and long.

Of those having three submarginal cells there are four families :—(1) *Colletes*, abdomen truncate at base ; (2) *Andrena*, abdomen ovate and entire at apex, with maxillary palpi as long, or longer, than the maxillæ ; (3) *Cilissa*, like *Andrena*, but having the maxillary palpi only half the length of the maxillæ ; and (4) *Halictus*, where the abdomen has a vertical incision at its apex.

Of the short-tongued bees without polliniferous hairs on the posterior tibiæ there are only two families :—(1) *Prosopis*, having two submarginal cells to the wings ; and (2) *Sphecodes*, having three submarginal cells. The second division, or long-tongued bees, are also divided into those without polliniferous organs and those with them.

Of those without polliniferous organs two families have two submarginal cells to the wings :—(1) *Stelis*, where the abdomen is rounded at the apex ; (2) *Cœlioxys*, where the apex of the abdomen is conical ; and four families have three submarginal cells :—(1) *Nomada*, with lanceolate abdomen ; (2) *Epeolus*, abdomen sub-truncate at the base, and obovate, with glabrous thorax ; (3) *Melecta*, abdomen subconical, thorax hirsute ; and (4) *Apathus*, where the entire body is densely hairy.

All the other families of the long-tongued bees have polliniferous organs, and may be thus divided :—Pollen conveyed on the venter, two submarginal cells, abdomen subclavate, first three joints of labial palpi continuous, terminal joint inserted before apex of third. (1) *Chelostoma ;* (2) *Heriades* differs in having the first two joints of labial palpi continuous, and the two last inserted before the apex of the second ; *Osmia* has the abdomen obovate and rounded at apex ; *Megachile* has the abdomen truncated at the base, segments slightly constricted, and not spotted with colour ; *Anthidium*, the segments are not constricted and are covered with yellow.

Next come those carrying pollen on their posterior legs. Two families have two submarginal cells :—(1) *Panurgus*, with lanceolate abdomen, clavate antennæ, and posterior legs, covered with long hair ; and (2) *Eucera*, with obovate abdomen, filiform antennæ, and posterior legs, covered with short dense hair.

The rest of the bees have three submarginal cells to the wings :—(1) *Anthophora*, short dense hair on the posterior tibiæ externally, abdomen obovate, first joint of labial palpi twice as long as the second ; (2) *Saropoda*, like *Anthophora*, excepting that the abdomen is sub-rotund, and that the first joint of the labial palpi is six times as long as the rest ; *Ceratina*, with long but loose hair on the entire posterior tibiæ externally and internally, the abdomen being sub-clavate ; *Bombus*, curved hair, fringing the edge only of the posterior tibiæ, the centre glabrous, the body densely hirsute, and spurs to all the tibiæ ; and, lastly, *Apis*, where the body is sub-pubescent and the posterior tibiæ have no spurs.

The above is epitomised from "Shuckard's British Bees," a work, perhaps, not without mistakes, but one that has most helped me to the knowledge which I possess of British bees.

Of the above twenty-six families, I have found fourteen in the neighbourhood of Kirton-in-Lindsey, viz., *Colletes*, *Andrena*, *Halictus*, *Sphedes*, *Cœlioxys*, *Nomada*, *Epeolus*, *Melecta*, *Apanthus*, *Osmia*, *Magachile*, *Anthophora*, *Bombus*, and, of course, *Apis*. The proboscis of each family is very characteristic.

C. F. GEORGE.

Mounting Fresh-water Polyzoa. — I extract from *Science Gossip*, 1879, p. 111, the following article, entitled *A New Method of Preserving Infusoria* :—"The following things will be necessary : A bottle of thin Canada balsam, diluted with chloroform, a hot-water plate, and a few dishes. The fixing solution, which is made in the following manner : To 25 cc. of chromic oxydichloride acid is added 50 cc. of water, with 5 cc. permanganate of potash. First draw a large ring of white wax upon the slide much larger than the covering glass ; then place the Vorticellas which you wish to preserve in the ring with some water. When they have attached themselves to the slide, some of the chromic-oxydichloride solution must be added, which will instantly fix the specimen in position. After remaining about three minutes the water may be poured out, and a few drops of chloroform added and poured off, the covering glass placed carefully on, and a few drops of dilute Canada balsam added so as to flow under the cover, which is then placed upon the hot-water plate to dry. Specimens preserved in this manner retain all the freshness of the living animal."

I also read in the *American Quarterly Microscopical Journal* the following from the *Zeitschrift für Mikroskopie*, "On the Preparation and Preservation of Microscopic Water Inhabitants" :—"For some time Duncker, of Bernau, has been selling a fluid in which Infusoria are well preserved, but its composition is a secret. The author has used a medium which he thinks may be the same ; at least, it acts equally well. In preserving Infusoria, Rhizopoda, Flagellata, Ciliata, Chlorophyllaceæ, Desmidiaceæ, etc., etc., the following process is followed :—In the centre of a lac cell, not fully hardened, place the organism in a few drops of water, apply the cover glass, and then place a couple of drops of pyroligneous acid, so that it will be drawn into the cell, cement the cover down, and the work is done. The objects may be stained by such anilin colours as are soluble in water (the best are anilin blue or diamond fuchsin) by staining in the following manner : Anilin blue, 1 part ; water, 200 parts, after filtering ; pyroligneous acid, 800 parts (all by weight). This stains the objects in a few hours, and they may then be mounted in pure pyroligneous acid. I have not tried these methods.

HENRY BASEVI.

Plant Crystals.—The outer coat of the bulb of Gladiolus contains some good examples of *Long Crystal Prisms:* these show well with the polariscope. Leaves of *Lemna trisulca* contain true *Raphides;* some are found in cells and some in intercellular spaces. Large intercellular spaces may be seen in the centre of these leaves containing air, which enables the leaves to float on the top of the water.

W. H. HAMMOND.

Plant Crystals.—I think all preparations containing Plant Crystals can be better shown without the polariscope by the staining process. The air cavities are found in all water plants.

C. BOSE.

Anguillula tritici belong to the class Entozoa, order Nematoidea.

H. F. PARSONS.

Trichina spiralis belong to the same order. "Measly pork" is that infested by the tapeworm, called in this stage *Cysticerci*, and not by the *Trichina*. (See note in April part, p. 122.)

H. F. PARSONS.

Lemna trisulca usually floats *in* the water, and not *on the surface*, as the other duck-weeds do.

H. F. PARSONS.

Crystals, Iodide of Lead.—Prepared by mixing drop solutions of acetate of lead and iodide of potassium, and allowing the crystals to grow on the glass slide. The mixing of various chemical solutions, and watching the growth of the smallest crystals on the stage of the microscope is very interesting, and frequently beautiful objects for examination with the polariscope are produced.

R. S. HUDSON.

Urticating Hairs of Caterpillars.—In reference to the hairs of the larvæ of Vapourer and Tiger moths, I was told when a boy that such caterpillars stung. Possibly the spikey nature of the hairs may produce irritation. Can anyone say?

W. LOCOCK.

In answer to above query, we have here (Portugal) very commonly the caterpillar of a moth, *Cnethocampa pityocampa,* the hairs of which are said to produce irritation. It makes its nest in the pine trees, "*Pinus maritima,*" in a colony, closely packed; they are dormant during the day, sallying out at night to feed on the trees. In one case I am told that a man's shirt was spread out to dry on the ground under one of these trees. After putting it on the irritation drove him nearly wild, and it was found that there was a nest of these caterpillars just above where the shirt had been laid. It is supposed that the hairs from the cast-off skins of these caterpillars fell on it.

I have examined these hairs under the microscope, and found nothing very remarkable in them, except that they seemed very sharp and needle-like, but will examine them again, as also those of an allied species which feed on the leaves of the Cistus, or Rock Rose, and report further.

W. C. Tait.

Plant Crystals.—I cannot agree with those who suggest that the polariscope should *not* be used in the examination of these objects. According to my old friend and tutor, Mr. Rainey, a microscopist should never be satisfied that he knows all about an object until he has examined it by *all* the means at his disposal; and certainly one can least of all afford to dispense with the aid of the polariscope, which often reveals to the observer differences of structure before unexpected and often impossible to ascertain in any other way.

J. W. Measures.

Bird's Head Processes.—In September last, while examining the bird's head processes on *Cellularia* received from Mr. Bolton, a minute Crustacean was seized by the leg and detained by the beak-looking appendage for three days, after which I was unable to make any further observations. This would seem to embody Mr. Goss's conjectures.

J. W. F. Dunlop.

Crystals of Santonine.—I believe that the wheel or disc-like form of the crystals of Santonine is due to the specimen having first been evaporated to an "amorphous film," and then allowed to absorb its "water of crystallisation" from the air. Many crystals, such as copper sulphate, baric chloride, salicine, etc., do this; the form of their crystals is then very different from the normal shape, but I believe that the *angles* of both forms of crystals will be found to be exactly alike.

H. M. J. Underhill.

EXPLANATION OF PLATE XXVI.

Fig. 1.—Head of Empis; *md.*, mandible; *mx.*, maxillæ; *lb.*, labium, × 25 diam.

,, 2.—Mouth organs of same, more highly magnified; *md.*, mandible; *lg.*, lingua; *mx.*, maxilla; *lbr.*, labrum, × 100 diam.

,, 3.—Teeth of Loligo, × 20 diam.

Drawn by Tuffen West.

,, 4.—Organism from a Hollow Flint, × 100 diam.

Drawn by A. Nicholson.

Reviews.

AMERICAN MEDICINAL PLANTS: An Illustrated and Descriptive Guide. By Millspaugh. (New York: Boericke and Tafel. 1886.)

The fourth section (fascicle) of this very beautiful and valuable work is to hand. Like each of its predecessors, it contains 30 finely coloured plates, with full descriptive letterpress, of medicinal plants. The author of this work is well known in his own country as a physician, botanist, and artist, and in bringing it out the publishers have engaged the highest order of typographic and lithographic skill. Two more fascicles are required to complete the set. The price of each section is $5.

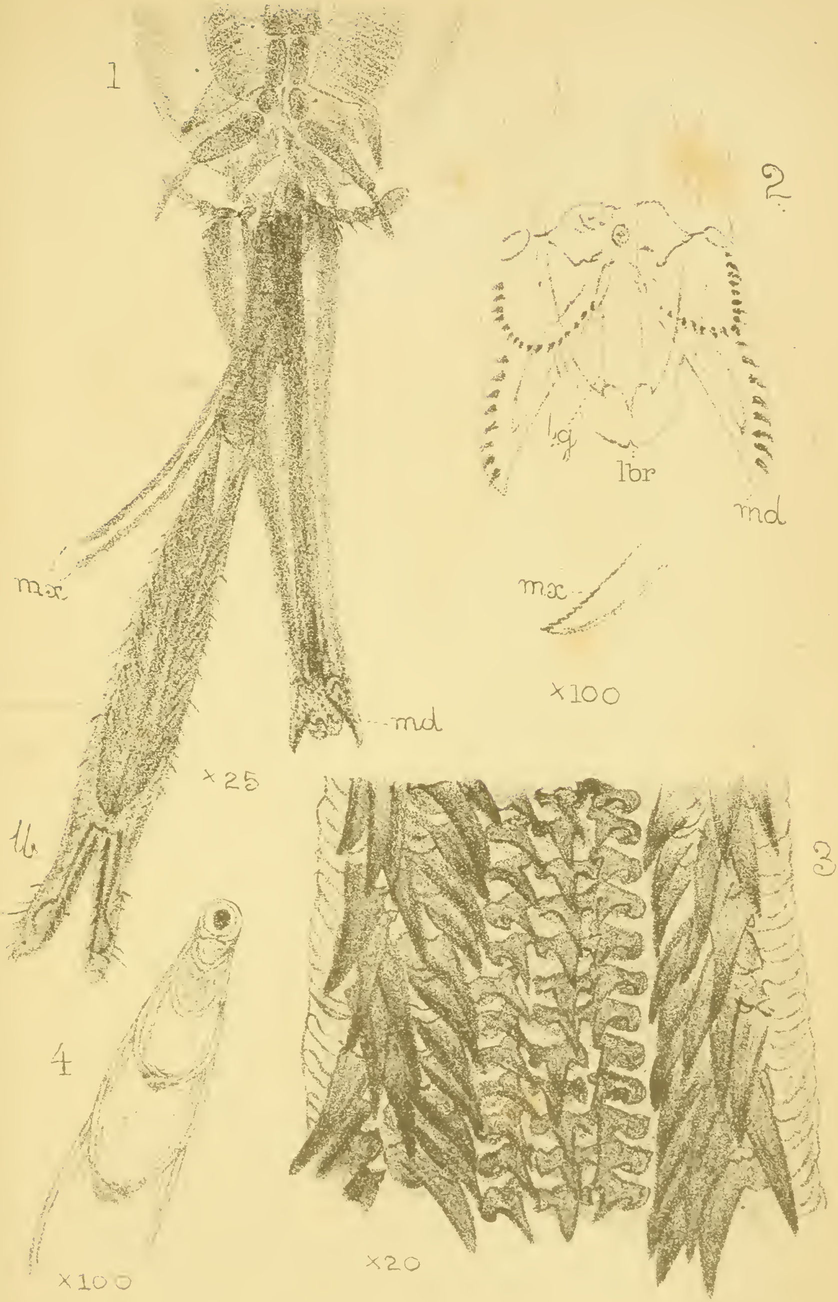
HOUSEHOLD REMEDIES for the Prevalent Disorders of the Human Organism. By Felix L. Oswald, M.D. Pp. 229. (New York: Fowler, Wells, and Co. 1886.)

A large amount of valuable information will be found in this book, which treats of Consumption, Dyspepsia, Climate, Fevers, Asthma, Nervous Maladies, the Alcoholic Habit, and many others. We are not sure that we agree with the author in all his assertions, but at the same time we find a deal of good common sense in the book.

A GUIDE TO HOMŒOPATHIC PRACTICE, designed for the Use of Families and Private Individuals. By J. D. Johnson, M.D. 8vo, pp. 494. (Philadelphia: F. E. Boericke. 1885.) Price $2.

The various diseases to which we are subject are described with sufficient minuteness of detail to enable anyone of ordinary ability readily to distinguish the complaint. The immediate and remote causes of the different maladies are pointed out, and the treatment very clearly and plainly described. Attention is also paid to the diet suitable for each case, and specific directions are given in regard to bathing, ventilation, and exercise.

THE TEMPERANCE TEACHINGS OF SCIENCE, adapted to the use of Teachers and Pupils in the Public Schools. By A. B. Palmer, M.D., LL.D.; with an Introduction by Mary A. Livermore. Post 8vo, pp. 163. Boston, U.S.A.: D. C. Heath and Co. 1886.) Price, 60 c.



Head of Empis. Teeth of Loligo &c

The object of the author of this little book has been to bring all, and especially young people, who may read it, to the rational conclusion and firm resolve, that in whatever form, as an article of "diet," of luxury, or as a beverage, alcohol is *useless* and *hurtful*, and that they will not take it.

FOOD MATERIALS and their Adulterations. By Ellen H. Richards. Cr. 8vo, pp. 183. (Boston, U.S.A.: Estes and Lauriat. 1886.)

We are told that the book before us is compiled from various sources, and is the work of ten years' experience in laboratory examination of food. Mrs. Richards is a strong believer in vegetable diet, and tells of a young woman who lived and flourished for a whole year on Indian corn-meal cooked in various ways, with only one dinner a-week at a friend's house, and that her whole living did not exceed $10, or about two guineas, a year.

MICROBES, FERMENTS, AND MOULDS. By E. L. Trouessart. Cr. 8vo, pp. xi.--314. (London: Kegan, Paul, Trench, and Co. 1886.) Price 5s.

This useful volume of the "International Scientific Series" enters very fully into the subject of Microbes. It is divided into eleven chapters. Chapter I. treats of Parasitic Fungi and Moulds: their habitat, station, and destructive habit, parasitic fungi of the skin and of insects. Chapter II. treats of ferments and artificial fermentation. Chapters III., IV., V., and VI. treat of Microbes, strictly so called, or Bacteria, the Microbes of the Diseases of Animals, of Human Diseases, and of Protection against them. Chapter VII. is a valuable one, describing the methods of laboratory research and culture of Microbes. The work contains 107 illustrations.

THE ROMANCE OF NATURAL HISTORY. By Philip Henry Gosse, F.R.S. First and Second Series. Cr. 8vo, pp. xiv.—344 and 363. (London: J. Nisbet and Co. 1886.) Price 3s. 6d. each.

The wonderful and entertaining stories contained in these volumes have much interested us. They embrace natural history in all its varied phases, and are illustrated by some 24 plates. No one reading these books will be likely to vote natural history a dull study.

OUR FANCY PIGEONS and Rambling Notes of a Naturalist: A Record of Fifty Years' Experience in Breeding, and Observation of Nature. By George Ure. Cr. 8vo, pp. xvi.—282. (Dundee: James P. Matthews and Co. London: Simpkin, Marshall, and Co. 1886.) Price 6s.

Mr. Ure is not only a "fancier" in the way that that term is generally used; he is thoroughly a naturalist, and the volume before us is interspersed with interesting anecdotes and notes. Chapter IV., on Shows and Showmen, abounds with admirable advice, and is specially worth reading. The last 70 or 80 pages are devoted to our native song-birds and other more common species. The volume is illustrated with six nicely-engraved plates.

UPLAND AND MEADOW. By Charles C. Abbott, M.D. Crown 8vo, pp. viii.—397. (New York: Harper Bros. 1886.)

Dr. Abbott is a naturalist, and one who possesses the rare gift of description and the ability of making his readers perceive the scenes and curiosities almost as if he were guiding them at the spot. He tells us that "To realise what a wealth of animal and vegetable life is ever at hand for him who chooses to study it, let a specialist visit you for a few days. Do not have more than one at a time, or you may be bewildered by their enthusiasm. I have had

them come in turns: botanists, conchologists, entomologists, microscopists, and even archæologists; yet they were all human and talked plain English. But, better than all, they were both instructive and amusing." He tells us what each found in their own special departments, so the doctor resolved to become each of these in turn, but after a few days fell into his own usual routine. The book is thoroughly readable and instructive.

FLOWERS, FRUITS, AND LEAVES. By Sir John Lubbock, Bart., F.R.S., M.P., D.C.L., LL.D., etc. Cr. 8vo, pp. xv.—147. (London: Macmillan and Co. 1886.) Price 4s. 6d.

This is a new volume of the "Nature Series," and comprises a chapter on Flowers from another volume of the series, now almost out of print, together with two subsequent lectures on Fruits and Seeds, and on Leaves; the subjects of Cross-Fertilisation of Flowers, their Scent, etc.; the Structure of Fruits and Seeds, their Dispersion, etc.; the beauty, variety, size, and form of Leaves are fully and most interestingly treated of.

HAND-BOOK OF PLANT DISSECTIONS. By J. C. Arthur, M.Sc., Charles R. Barnes, M.A., and John M. Coulter, Ph.D., Editors of the *Botanical Gazette*. Cr. 8vo, pp. xi.—256. (New York: Henry Holt and Co. 1886.) Price $1.50.

This book will prove of much value to the botanical student. By the methods adopted, all plants are to be subjected, first, to what the authors call "gross anatomy," or dissection and observation by aid of the pocket-lens only; then, passing to "minute anatomy," each part is to be carefully examined with the compound microscope. The directions for finding the different parts have been made as simple and explicit as possible. The apparatus required—re-agents and material—have been reduced to a minimum. The authors have endeavoured, and we hope with much success, to provide a guide to the study of a few common plants, in which simple appliances, coupled with perseverance and keen observation, on the part of the student, are the very essentials.

BRITISH FUNGI, LICHENS, AND MOSSES, including Scale Mosses and Liverworts. By E. M. Holmes, F.L.S., F.R.M.S., etc., and Peter Gray, A.B.S. Edin. Cr. 8vo, pp. 94. (London: Swan Sonnenschein and Co. 1886.) Price 1s.

We are always glad to welcome a new volume of "The Young Collector" series. This, like all its predecessors, gives a good deal of advice, which will be welcome to the young collector, as to the methods of collecting, preserving, and examining these interesting plants, and how to arrange them in a herbarium.

PRIMROSES, COWSLIPS, POLYANTHUSES, AND OXLIPS. By Philanthus. Cr. 8vo, pp. 16. Price 6d.

THE TOMATO, with Cultural Directions for Maintaining a Continuous Supply of the Fruit. By William Iggulden. Pp. 73. Price 1s.

CACTACEOUS PLANTS: Their History and Culture. By Lewis Castle. Pp. 93. Price 1s.

MUSHROOMS FOR THE MILLION, with a Supplement. A Practical Treatise on the Cultivation of the most Profitable Outdoor Crop Known. By J. Wright, F.R.H.S. Fourth edition, pp. 126.

ORCHIDS: Their Structure, History, and Culture. By Lewis Castle. Pp. 106. Price 1s.

(London: *Journal of Agriculture* Office.)

The above five little books are all nicely illustrated; the three last are also nicely bound in cloth. They each treat their respective subjects very thoroughly—*e.g.*, in that on the TOMATO we have chapters for amateurs and growers of fruit for market, an estimate of varieties, and a list of useful receipts. That on ORCHIDS gives an account of Orchid life, its flowers, mysteries, fertilisation, etc., with a catalogue of the literature on the subject. That on CACTACEOUS PLANTS, their structure, history, culture, etc. The volume on Mushrooms is in its fourth edition, and tells us how to raise this most remunerative fungus. The cost of production per square yard is said to be about 5s., and the value of the produce therefrom 15s., giving a clear profit of 10s., or, allowing for spaces, etc., a profit of about £950 per acre. We think these little books will repay a perusal.

THE HORSE: His Diseases and how to Cure them. Pp. 140.

THE DOG: His Diseases and how to Cure them. Pp. 144.

Both by George S. Heatley, M.R.C.V.S. (Edinburgh: Wm. Paterson. 1886.) Price 1s. 6d. each.

Two useful books belonging to the series, "Every Man his own Vet." The diseases incident to these faithful and useful animals are described and their remedies suggested.

HEALTH LECTURES FOR THE PEOPLE. Vols. VII., VIII., IX. Cr. 8vo, pp. 148, 165, 158. (Manchester: John Heywood.) 1s. each.

These are portions of the series of "Health Lectures for the People," and were delivered in Manchester during the winters of 1883—4, 1884—5, 1885—6, and cover a variety of subjects—*e.g.*, Vol. VII. treats of Breathing, Washing, Working, Drinking, the Eye, Eating, the Ear, Parents and Children, Sleep and Rest, Thinking; Vol. VIII. is devoted to the subject of House Construction, with special reference to healthy occupations; Vol. IX. treats of Food and Drinks under the following headings: Diet, Milk, Poultry, Fatty Foods and Condiments, Fish, Bread and other Farinaceous Foods, Beer, Wines, etc., the Preparation of Food, Tea, Coffee, Cocoa, etc., Fruits.

BURTON'S MODERN PHOTOGRAPHY. By W. K. Burton, C.E. Sixth and enlarged edition. Cr. 8vo, pp. iv.—172. (London: Piper and Carter. 1886.) Price 1s.

This (No. 7 of the "Photographic Handy Books") was formerly published as the A B C of Modern Photography. Whilst retaining as much as possible its simplicity of explanation, it contains several additional chapters on the more advanced departments of the art. The general introduction of late of paper as a substitute for glass in the camera has necessitated a chapter treating of paper films for negative work.

LA PHOTOGRAPHIE EN BALLON. Par Gaston Tissandier. Pp. 46.

TRAITÉ PRATIQUE DE GRAVURE HÉLIOGRAPHIQUE en Taille-Douce, Sur Cuivre, Bronze, Zinc, Acier, et de Galvanoplastie. Par V. Roux. Pp. 44.

MANUEL DE L'IMPRIMEUR HÉLIOGRAPHE, Complément du Traité d'Héliogravure Pratique et du Traité de Zincographe. Par V. Roux. Pp. 30.

La Photographie Appliquee aux Etudes d'Anatomie Microscopique. Par H. Viallanes. Pp. 66.

Guide Pratique du Photographe Amateur. Par G. Vieuille. Pp. 108.

Traité Pratique de Photogravure, sur Zinc et sur Cuivre. Par Geymet. Pp. 206.

Traité Pratique de Peinture et Dorure, sur Verre emploi de la Lumière, Application de la Photographie. Par E. Godard. Pp. 62.

La Photographie sans Laboratoire, Procédé au Gélatino-bromure. Par Eug. Dumoulin. Pp. 58.

Manuel de Photographie et de Calcographie a l'Usage de MM. Les Graveurs sur Bois, sur Métaux, sur Pierre. et sur Verre. Par V. Roux. Pp. 39.

Traité Pratique des Émaux Photographiques: Secrets, Tours de mains, Formules, a l'Usage du Photographe émailleur sur Plaques, et sur Porcelaine. Par Geymet. Pp. 161. (Paris: Gauthier-Villars. 1886.)

The above ten volumes form in themselves a small library of very capital works on the various branches of Photography. As it would be quite impossible in the short space at our disposal to write a separate notice to each of these books, we have copied their titles *in extenso*, thus giving a good idea of their contents, and we think we may safely assure our readers that each volume thoroughly fulfils the promise there made. A few of them are illustrated both with engravings and photos.

Philip's New Excelsior Atlas, containing upwards of 120 Maps and Plans. 4to. (London: George Philips and Son. 1886.) Price 1s.

A remarkably cheap and useful Atlas, containing maps of the world, of the different continents, and of the principal countries, with the chief towns, rivers, etc., very distinctly marked. The maps are all coloured, and the atlas is bound in stiff, varnished paper covers.

Bacon's Cycling Road-Maps of England, in Seven Sheets, with the Main Roads specially coloured. Price: in cloth case, 1s.; on flexible cloth, 2s. 6d.; or on cloth, cut to fold, 3s. 6d. (London: G. W. Bacon, Strand. 1886.)

Mr. Bacon has favoured us with a set of these capital maps, and we can assure the tourist, whether "tramp" or "cyclist," that he will find them invaluable. We have carefully studied the maps of those localities with which we are most acquainted, and believe them to be very accurate.

Bicycles and Tricycles of the year 1886. By Harry Hewitt Griffin. Cr. 8vo, pp. 170. (London: L. Upcott Gill. 1886.) Price 1s.

To quote the full title of this book, it is "A Chronicle of the New Inventions and Improvements, and a permanent record of the Progress, of the Manufacture of Bicycles and Tricycles. Designed also to assist intending purchasers in the choice of a Machine." It is divided into three sections—Bicycles, Tricycles, and Accessories, and is illustrated with a great number of woodcuts.

History and Antiquities of the Town and Neighbourhood of Uttoxeter, with Notes of Adjoining Places. By Francis Redfern. Cr. 8vo, pp. 465. (Hanley: Allbut and Daniel. London: Simpkin, Marshall, and Co. 1886.) Price 12s. 6d.

The author has devoted no little time and research to the compilation of the work before us. He traces the history of this ancient town to prehistoric times. The work is enriched with engravings of flint implements and Roman and other pottery found in the neighbourhood, and with views of churches and other famous buildings.

England as Seen by an American Banker: Notes of a Pedestrian Tour. Cr. 8vo, pp. 334. (Boston, U.S.A.: D. Lothrop and Co. 1886.) Price $1.50,

The author of this very interesting work has a way of making his readers see what he sees, and he has a way also of discovering those little traits which make those whom he is among differ from the people of his own country. He charmingly describes the scenery of the various districts through which he travelled, the people he saw, and the facts he collected. Some of these facts must be taken *cum grano salis*. The book is written in a very agreeable and easy style, and will doubtless be read both with amusement and pleasure by his English entertainers.

From Korti to Khartum: A Journal of the Desert March from Korti to Gubat, and of the Ascent of the Nile in General Gordon's Steamers. By Col. Sir Charles W. Wilson, K.C.B., K.C.M.G., D.C.L., F.R.S., R.E., etc. Sixth edition. Cr. 8vo, pp. xxix.—317. (Edinburgh and London: W. Blackwood and Sons. 1886.)

This interesting journal was written by Colonel Sir Charles Wilson immediately after his return to Korti whilst all the events were fresh in his memory, and gives a minute account of his work in the Soudan campaign. There is a map to assist the reader in the determination of geographical positions, and the interest which is aroused by a detailed account of the exciting events of the journey—notably, the battle of Abu Klea—leaves such a clear impression of the district, and the demands it makes upon human skill and endurance, as will cause us to appreciate more than ever the heroism displayed by our soldiers in their difficult task.

Paterson's Guide to the Rhine Provinces, with Maps and Plans. Pp. 174. (Edinburgh: William Paterson. 1886.) Price 1s. 6d.

This is a concise and, we make no doubt, a reliable handbook, giving all the information possible in a book of suitable size for the traveller. The local maps and plans are all tinted, and the letterings and names of places and streets are very distinctly printed.

South Wales and the Wye District of Monmouthshire. By C. S. Ward, M.A., and M. J. B. Baddeley, B.A. Pp. xvi.—174. (London: Dulau and Co. 1886.) Price 3s. 6d.

A closely printed and most useful pocket-guide to South Wales and the Wye district, illustrated with 17 maps and plans. In the various routes all the places of note are briefly described, a much more lengthy account being given of those places at which the tourist is supposed to stay.

PUPIL-TEACHER'S GEOGRAPHICAL YEAR-BOOK, Atlas, and Geography. (Edinburgh and London: W. and A. K. Johnston. 1886.) Price 2s. 6d.

This will be found a most useful book for the pupil-teacher, as it gives a large amount of valuable information in a very condensed form. This is the fourth year of publication of this little year-book. It treats of America and Oceanea, and Astronomy, and contains five double-page geographical maps and three of astronomical diagrams.

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300 PROBLEMS in Chemical Physics and Specific Gravity, with Key. By Henry Wootten. Cr. 8vo, pp. 91. (London: Simpkin, Marshall, and Co. 1886.) Price 3s.

Students in chemistry will be glad to know of this book. The problems are arranged under their various subject-headings, and although simply expressed will be found to be of considerable importance. Each problem is worked out in full, and the method of working is explained.

WILLS' PRELIMINARY QUESTIONS, being the Questions given at the Pharmaceutical Society's Preliminary Examinations from 1881 to 1885 inclusive. With Answers and Essays.

This may almost be considered as an accompanying work to the above. The examination papers are divided into three subjects, viz.—Latin, Arithmetic, and English, and are fully answered at the end of the book. A youth about to pass his "preliminary" will do well to work through this book first.

ELEMENTS OF PLANE GEOMETRY: Part I. corresponding to Euclid Books I. and II., Part II. corresponding to Euclid Books III., IV., V., and VI. 2 Vols., cr. 8vo, pp. 138—197. (London: Swan Sonnenschein and Co. 1886.) Price 2s. 6d. each.

The Association for the Improvement of Geometrical Teaching have in these volumes issued the Syllabus of Plane Geometry which was published in 1875, to which they have added demonstrations and exercises. As might be expected in publications of this society, the proofs are set forth in a clear and intelligible manner, and the exercises exhibit great carefulness in their selection and progressiveness. As the educational value of this science has of late been more urgently insisted upon, we advise teachers who are in search of text-books to place these in the hands of their pupils.

THE SCIENCE AND ART OF ARITHMETIC, for the Use of Schools. By A. Sonnenschein and H. A. Nesbitt, M.A. Cr. 8vo. Part I., Integral, pp. xii.—174. Parts II. and III., Vulgar Fractions and Approximate Calculations, pp. x.—271. (London: Swan Sonnenschein and Co.)

We think this is the most useful and at the same time most interesting treatise on arithmetic that we have yet met with. Pupils who are taken carefully through this work will gain such a knowledge of the science and such a grounding in the function of numbers as will be of lasting service to them; whilst the clear exposition and consequent mastery of every principle will make repetition needless. We have known students who have perused this book gain very high places in their "exams."

1,750 EXAMINATION QUESTIONS on English History, with 4,900 References to Standard Works where the Answers may be found. By "Oxon." Cr. 8vo, pp. xi.—198. (London: Swan Sonnenschein and Co. 1886.) Price 3s. 6d.

In examinations where English history will form one of the subjects, the student will do well to be prepared to answer these questions. A catalogue of about twenty works are given, and the exact page referred to, on which each answer will be found. Should the student wish to possess these books, the prices at which they can be purchased are given. But they may doubtless be met with at most public libraries. The author distinctly states that no unnecessary page is ever referred to.

STOPS and How to Punctuate: A Practical Handbook for Writers and Students. By Paul Allardyce. 16mo, pp. 83. (London: T. Fisher Unwin. 1886.) Price 1s.

This handy little book has a chapter devoted to each of the stops, dashes, hyphens, etc. etc., as used in all printed books, and one also on the proper method of correcting printers' proof-sheets.

CREATION AND ITS RECORDS: A Brief Statement of Christian Belief, with Reference to Modern Facts and Ancient Scripture. By B. H. Baden-Powell, C.I.E., F.R.S.E. Cr. 8vo, pp. vii.—244. (London: Hodder and Stoughton. 1886.) Price 6s.

Much thought is evinced in the writing of this book. It consists of sixteen chapters, with an appendix. We have read chapters xii. and xiii. with considerable interest. They treat of the method of interpreting the narrative of the creation and the Genesis narrative considered generally. Two interesting diagrammatic charts are given, one showing plant-life from the earliest ages, the other animal life for the same geological period.

SOLAR HEAT, GRAVITATION, AND SUN-SPOTS. By J. H. Kedzie. Cr. 8vo, pp. xii.—304. (Chicago: C. S. Greggs and Co. 1886.) Price \$1.50.

The theories propounded by the author are quite new to us, and will require more study than we have yet been able to give to them before we shall be able to pass any satisfactory opinion. He says:—"On the subject of solar heat there are not less than five or six different theories advanced by eminent scientists. A new theory cannot, therefore, be considered as conflicting with any *settled* doctrine on the subject."

THE STORY OF THE HERSCHELS, a Family of Astronomers. Cr. 8vo, pp. 117. (London: T. Nelson and Sons. 1886.)

This little book, which opens with an account of some of the pleasures to be derived from the study of astronomy, gives some interesting biographical particulars of Sir Wm. Herschel, Sir John Herschel, and Caroline Herschel. The frontispiece to the volume is a coloured portrait of Sir John Herschel.

LITTLE ASKER, or Learning to Think: A Story for Boys and Girls. By J. J. Wright. Cr. 8vo, pp. 187. (London: Swan Sonnenschein and Co. 1886.) Price 1s. 6d.

"Asker" is the pet name given to the hero of this little book in consequence of his propensity for asking questions about all that he sees. These questions are answered by his father and friends simply and intelligently. It is a capital book to give to a little boy.

SHORT SIGHT, LONG SIGHT, AND ASTIGMATISM: An Elementary Guide to the Refraction of the Eye. By Geo. Frederick Helm, M.A., M.D., F.R.C.S., etc. Cr. 8vo, pp. 103. (London: J. and A. Churchill. 1886.) Price 3s. 6d.

The object of this book is to place before students and practitioners an elementary treatise on the errors of refraction of the eye, and to explain in simple language their nature and the means whereby they may be satisfactorily corrected.

How to Use our Eyes and How to Preserve Them from Infancy to Old Age. By John Browning, F.R.A.S., F.R.M.S., etc. (London: Chatto and Windus. 1886.) Price 1s.

Mr. Browning here gives us his experience in the construction and adaptation of spectacles. The present edition (the fourth) has been carefully revised, and is illustrated with 55 engravings.

Records of an Active Life, with Incidents of Travel and Numerous Anecdotes. By Samuel Taylor. Cr. 8vo, pp. 90. (Hanley: Allbut and Daniel. London: Simpkin, Marshall, and Co. 1886.) Price 2/6.

Mr. Taylor, the well-known originator and promoter of Penny Readings, gives in the little book before us some interesting records or reminiscences of his early life and of his travels in Russia, Sweden, etc. The book is very pleasantly written.

Modern Language in Education. By G. F. Comfort. (Syracuse, New York: C. W. Bardeen. 1886.)

This little pamphlet of 40 pages is a reprint of a paper published in *Scribner's Magazine*. It discusses the relative merits and claims of the ancient and modern languages in the general system of education.

Common Objects of the Country. By Rev. J. G. Wood.

Common Objects of the Seashore, including Hints for an Aquarium. By Rev. J. G. Wood.

The Spectator (Choice Selections).

The Professor at the Breakfast-Table (Selections). By Oliver Wendell Holmes.

The Comic Poets of the Nineteenth Century: Poems of Wit and Humour. Selected and arranged by W. Davenport Adams.

Chinese Gordon: A Succinct History of his Life. By Archibald Forbes.

All 16mo, pp. 160. (London: George Routledge and Sons. 1886.) Price 3d. and 6d. each.

Six volumes of "Routledge's World Series," nicely bound in cloth and well printed. Each volume has an introduction by the Rev. Hugh Reginald Haweis, M.A. The subjects are well selected, and the books deserve a place in the library of every youth.

A Mechanic's Tour Round the World. By T. Lowe. (London: Wyman and Sons. 1886.) Price 1s.

The writer visited South Africa, Canada (including British Columbia), the United States, Australia, etc. At Kimberley, South Africa, he worked in the diamond-fields. He gives us some entertaining notes and sketches of his travels and of the various occupations in which he engaged.

Old Edinburgh Pedlars, Beggars, and Criminals.

Old Edinburgh Beaux and Belles. Post 8vo, pp. 107, 112. (Edinburgh: Wm. Paterson. 1886.) Price 1s. each.

Two very amusing books, illustrated with quaint engravings of the various characters described.

Scottish Jests and Anecdotes. Collected by Robert Chambers. 16mo, pp. 252. (Edinburgh: William Paterson. 1886.) Price 1s.

One of a series of entertaining books known as "Nuggets for Travellers." Many of the anecdotes are exceedingly witty, and all are amusing.

Diet in Relation to Age and Activity. By Sir H. Thompson, F.R.C.S. (London: Kegan Paul, Trench, and Co. 1886.) Price 1s.

A reprint, with a few additions, of a paper which appeared in the *Nineteenth Century* a short time ago. The author tells us that he has been compelled to accept the conclusion that more mischief in the form of actual disease, of impaired vigour, and of shortened life, accrues to civilised man in our own country from erroneous habits of eating than from the habitual use of alcoholic drink, considerable as he knows that habit to be.

Good Things of Life.

More Good Things of Life.

(Glasgow: David Bryce and Son. 1886.) Price 1s. each.

These are not good things in the way of eating and drinking, as from the titles we were led to suppose, but consist each of about 60 very laughable sketches.

Current Notes and Memoranda.

Notice to the Members of the Postal Microscopical Society.—The Annual Meeting of the Society will be held at the Holborn Restaurant, High Holborn, on Thursday, October 7th, at 6 o'clock p.m. It is hoped that a large number of members will attend. When the official business is concluded a dinner will be served at 7.30, to which members of the Society may invite their friends. We may remark that this is the only opportunity afforded for the members of distant branches of the Society to meet each other.

We have pleasure in stating that we have received the first and second parts of Mr. Cole's very excellent *Studies in Microscopical Science.* These, like the last volume, are divided into four sections. Section 1 is devoted to Botanical Histology, subject Vegetable Physiology, and treats of — 1. The vegetable cell. 2. The cell wall: its modifications and physical properties; illustrated by a section through the apex of the stem of fig, and a section of stem of *Clematis vitalba.* Section 2 relates to Animal Histology, and is illustrated by a section of the Mammalian Testis, and Spermatozoa of the Vertebrata. Section 3 treats of Pathological Histology, the subjects being the Normal Kidney and Congestion of the Kidney. Section 4, Popular Histology, the subject chosen being the Sea Fans, illustrated by slides of Spicules of *Gorgonia flabellata* and *Thyone papillosa.* The slides are in Mr. A. C. Cole's best style. Intending subscribers should send in their names at once to Messrs. Hammond and Co., 136, Edmund Street, Birmingham.

List of Plates.

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REVIEWS.

C. Seers, Printer, 1, Argyle Street, Bath.